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NUCLEAR SCIENCE ABSTRACTS

A semimonthly publication of the USAEC Division of Technical Information, Edward J. Brunenkant, Director. Published by the USAEC Division of Technical Information Extension, Robert L. Shannon, Extension Manager.

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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 12095, 12098, 12223, and 12251.

10243 (AAEC-TM-326) INFRARED DETERMINATION OF RESIDUAL HYDROGEN IN DEUTERATED INORGANIC COMPOUNDS. Whateley, T. L.; Whittem, R. N. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). May 1966. 8p. Dep. mn.

An accurate infrared spectroscopic method of determining traces of H_2O in high-purity D_2O was used to estimate H_2O in compounds containing both H_2O and D_2O, and exchangeable hydrogen in compounds containing both hydrogen and deuterium. (auth)

10244 (AECL-2647) SPECTROFLUORIMETRIC DETERMINATION OF SUB-MICROGRAM CONCENTRATIONS OF URANIUM IN AQUEOUS SOLUTION. Bruce, T.; Ashley, R. W. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Nov. 1966. 8p. Dep. mn. AECL $0.50.

The fluorescence of U^{6+} in phosphate solution was re-examined to determine sub-microgram concentrations of uranium. The effect of phosphoric acid and phosphate ion concentration on the relationship between fluorescence intensity and uranium concentration was determined. At optimum conditions, 0.3M H_3PO_4 and 1.74M $NH_4H_2PO_4$, 0.05 μg U/ml can be measured with an error of ±0.01 μg uranium. (auth)

10245 (AECL-2648) COLLECTION AND DETERMINATION OF TRACE AMOUNTS OF URANIUM USING CELLULOSE PHOSPHATE ION EXCHANGE PAPER. Bruce, T.; Ashley, R. W. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Nov. 1966. 8p. Dep. mn. AECL $0.20.

Cellulose phosphate ion exchange paper was investigated as a means of collecting trace amounts of uranium prior to its determination. Spectrofluorimetric determination of uranium directly on the paper is not feasible for quantitative analysis, but can be used for qualitative analysis. X-ray fluorescence measurements on the paper can be used for quantitative measurements down to 10 μg U with a precision of ±4 μg. (auth)

10246 (AECL-2829) SPECTROPHOTOMETRIC DETERMINATION OF ZIRCONIUM IN BISMUTH-LEAD ALLOYS USING ALIZARIN RED S. Hardy, P. S. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Nov. 1966. 8p. (CRDC-1251). Dep. mn. AECL $0.20.

Zirconium in bismuth-lead alloys can be determined by the Alizarin Red S method after extraction from lead and bismuth with 0.5M 2-thenoyltrifluoroacetone (TTA) in xylene. Recoveries are 99.6 ± 1.9% from samples containing 20 to 400 ppM Zr. Metallic impurities likely to be present in the samples considered do not interfere. (auth)

10247 (AERE-R-5293) DETERMINATION OF SELENIUM IN ZIRCONIUM-SELENIUM ALLOYS. Carter, T.; Parker, A. (Atomic Energy Research Establishment, Harwell (England)). Dec. 1966. 12p. Dep. mn. BIS $0.50, HMSO 2s. 6d.

The alloy was dissolved in a mixture of HNO_3 and HF, and the excess fluoride was complexed with H_3BO_3. A piazselenol was formed with 3,3'-diaminobenzidine; this was extracted into toluene and measured absorptiometrically. Interferences due to zirconium were eliminated by complexing with EDTA. The coefficient of variation was 1% at the 100 μg level, and quantities of Se as low as 0.2 μg were detected. No bias was apparent in the presence of Zr. (auth)

10248 (CNAEM-39) DETERMINATION OF THALLIUM BY ACTIVATION ANALYSIS BASED ON THE REACTION $^{203}Tl(n,2n)^{202}Tl$. Talat-Erben, M.; Okar, Sevim (Cekmece Nuclear Research Center, Istanbul (Turkey)). Sept. 1966. 14p. Dep. mn.

An activation analysis based on the reaction $^{203}Tl(n,2n)^{202}Tl$ is discussed. The product isotope ^{202}Tl has a convenient half-life of 12 days and is a gamma emitter, thereby making the determination specific. Because of the rather high threshold (8 to 9-MeV) for this reaction, the sensitivity was only about 20 μg of thallium for samples irradiated for 30 hr in the close-vicinity of the reactor fuel in a total flux of 10^{13} n/cm²/sec. (auth)

10249 (DP-MS-66-55) PROBABILISTIC METHODS OF APPRAISING COVERAGE OF BIOASSAY SAMPLING PROGRAMS. Sanders, S. Marshall Jr.; Knight, F. Delano (Du Pont de Nemours (E.I.) and Co., Aiken, S. C. Savannah River Lab.). Sept. 28, 1966. Contract AT(07-2)-1. 18p. (CONF-661018-2). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From 12th Annual Bioassay and Analytical Chemistry Meeting, Gatlinburg, Tenn.

Methods for expressing the coverage afforded by any bioassay sample collection program are discussed. The probabilistic method is not restricted to plutonium, but has general applicability to all sampling procedures. Changes in the interval between urinalyses or the fraction of the group sampled can be related to the work load of the laboratory and, with some knowledge of the metabolism of the radionuclide, to the probability of detecting an assimilation. Sample collection programs can now be compared, appraised, or tailor-made to meet desired specification of economy of operation, probability of detection, and level of assimilation. (auth)

10250 (EUR-2771.d) EMISSIONSSPEKTROGRAPHISCHE UNTERSUCHUNGEN AN PLANKTONPROBEN BEKANNTER BIOLOGISCHER ZUSAMMENSETZUNG. (Investigations by Emission Spectrography on Plankton Samples of Known Biological Composition). Bielig, H.-J.; Schmidt, H.-L.; Rohns, G.; Klinger, E. (Universitaet des Saarlandes, Saarbruecken (West Germany). Institut fuer Biochemie). Nov. 3, 1965. 28p. (In German). Dep. mn.

Seventy-six samples of marine plankton collected during the years 1957 to 1959 in the Gulf of Naples, Italy and in the Mouth of Moroiso Cove, Misaki, Japan were completely ashed and freed from SiO_2 after their biological composition was established. The ashes were investigated by emission spectrography. By comparison with reference spectra it was ascertained which of 38 elements were present. Comparison of the blackening of selected absorption lines in the spectra of plankton ashes and of artificial ashes of known elementary composition, permitted quantitative determination following 13 bioelements: P, Cs, Sr, Ca, Cu, Zn, V, Cr, Mn, Mo, Fe, Co, and Ni. The content of Ag as an accidental trace element was established. The amount of Si was obtained from the loss of weight after treatment with hydrofluoric acid. The content of most elements whose presence was proved by Terzaghi (1959) from the radiation of their radioactive isotopes, was lower than the limit of detection by the emission spectrographic method. Graphs of the relative amount of each of the determined elements and of the relative biological composition as a function of the collection date permitted comparison of these parameters. There was in nearly all cases parallelism between the frequency of diatomees and the amount of Si in the different plankton samples. Vanadium was found in samples without any tunicates. Generally the contents of Ca and Sr were found to be in constant relation. Maximum contents of

Sr, Cu, Si, Mo, and others were found at definite times of the year. The maximum values of Co and V were independent of the season. The concentration of bioelements in the ashes of Misaki plankton was up to a factor of ten below that of Naples plankton. This was very probably due to a different content of sea salt. The total uptake of bioelements from 1 m^3 of sea water by the plankton contained in it, was, independently of the collection place, lower than 1% of the amount present. Possible reasons for the higher uptake of Cs and Fe are discussed. An enrichment factor ≥ 100 of biolements in the plankton ashes (in relation to the average of those in the same amount of sea salt) was found only for P, Cs, and Zn; in some cases this was established also for V, Fe, and Co. The up to 20-fold enrichment of Cr and Ni did not allow a decision on whether these metals are to be considered as bioelements in plankton. Considering all these data it is evident that more precise results on the specific enrichment (function) of bioelements in plankton organisms are to be expected by investigation of individual species instead of a collective of organisms. (auth)

10251 (K–1667) THE MOLAL FREEZING POINT DEPRESSION CURVE OF URANIUM HEXAFLUORIDE AND ITS APPLICATION TO A METHOD OF ANALYSIS. Hedge, W. D. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Jan. 17, 1967. Contract W-7405-eng-26. 27p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The freezing point curves for the binary systems UF_6– trichloroheptafluorobutane ($C_4Cl_3F_7$), UF_6–perfluorodimethylcyclohexane (C_8F_{16}), and UF_6–dichlorotetrafluoroethane ($C_2Cl_2F_4$) were determined over the ranges from 0 to 2.5 mole % of the individual solutes in uranium hexafluoride. In addition, the UF_6– HF system as determined by Wertz and Hedge was included on a molal basis. The observed molal freezing point depressions produced constants of 19.4, 19.6, 19.2, and 18.8°C per mole of solute added to 1000 grams of uranium hexafluoride, respectively. The average of these constants, 19.2 ± 0.7, is the molal freezing point constant. The deviations resulting from non-ideality are discussed. Corrections for these deviations are applied by extension of observed freezing point depressions and ratio of liquid volume to total volume. A method is introduced whereby the individual gross, liquid, and vapor compositions of the binary systems at their triple points may be estimated. (auth)

10252 (RT-CHI–(66)26) METODO DI DETERMINAZIONE DIRETTA DI ALCUNI PRODOTTI DI FISSIONE IN MISCELA BASATO SULLA SOTTRAZIONE SUCCESSIVA DI SPETTRI. (Method for Direct Determination of Various Fission Products by Successive Spectrum Stripping). Pompei, V. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 22p. (In Italian). Dep. mn.

A rapid method that allows direct determination of fission products by spectrum stripping is described. The method can be employed for routine determinations of some significant fission products in irradiated power reactor fuels cooled for at least 100 days. The standard deviation is less than 8%. (auth)

10253 (SGAE-CH–31/1966) BESTIMMUNG VON VERUNREINIGUNGEN IN ROTEM PHOSPHOR DURCH NEUTRONENAKTIVIERUNG UND GAMMASPEKTROMETRIE. (Determination of Impurities in Red Phosphorus by Means of Neutron Activation and Gamma Spectroscopy). Patek, P.; Sorantin, H. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Institut fuer Chemie). 1966. 15p. (In German). Dep. mn.

In six samples of red phosphorus of different origin trace elements were determined by non-destructive neutron activation analysis. Only those nuclides were determined, which have a half-life shorter than 15 hr. Qualitatively 7 elements were detected, some of them were analysed quantitatively, comparing their activity with simultaneous irradiated standards. Large differences in the amount of trace elements in the different phosphorus samples were observed. Sodium and aluminum were the most important contributors to the impurity level. (auth)

10254 (TEES–2671-5) INVESTIGATIONS IN AUTOMATED ACTIVATION ANALYSIS. (Texas Agricultural and Mechanical Univ., College Station. Activation Analysis Research Lab.). Aug. 31, 1966. Contract AT(40-1)-2671-1. 157p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments in studies on activation analysis are described. Also included are summaries on the use of automated activation analysis system for the measurement of pesticide residues in plant materials and destructive as well as nondestructive activation analyses of biomedical samples. In addition, two dimensional activation analysis of commercially pure aluminum foil and the investigation of the potentialities of charged particle activation analysis are described. Additional basic and applied research projects include the development of instrumental methods to reduce matrix interference in the analysis of trace elements, measurement of sensitivities for 14-MeV neutron activation analysis, neutron activation techniques for lunar surface analysis, 14-MeV neutron cross section measurements, use of atomic absorption as an alternate analytical tool, and the recoil studies of the fission products from ^{238}U induced by 14-MeV neutrons. Two computer programs—one for the determination of the peak areas of gamma ray peaks and the other for stripping of a complex gamma ray spectrum into its components—are also described. (P.C.H.)

10255 (UCID–15061) THE DETERMINATION OF BORON IN ELEMENTAL BORON AND BORON CARBIDE. General Chemistry Technical Note No. 206. Rigdon, L. P.; Colman, D. M. (California Univ., Livermore. Lawrence Radiation Lab.). July 1, 1965. Contract W-7405-eng-48. 3p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Two methods of determining the boron in elemental boron and boron carbide are described in detail. Carbonate fusing and refluxing in strong acids were both used in the dissolution of B_4C and elemental boron of about 95% purity alone and in admixture with organic materials. No significant difference in the boron assay of the resultant solutions from the two methods was found. However, on some occasions in sodium carbonate fusion the organic material would burn out before the sodium carbonate reached the fused state. The assays in such cases were always low in boron. (D.H.M.)

10256 (UCID–15062) SPECTROGRAPHIC DETERMINATION OF IMPURITIES IN BORON. SEPARATION OF IMPURITIES AND COLLECTION IN GALLIUM OXIDE. General Chemistry Technical Note No. 153. Morris, W.; Lim, R. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 22, 1964. Contract W-7405-eng-48. 7p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A method for separating impurities from boron, which involved converting the boron metal to boric acid and reacting the latter with methanol to form the ester, methyl borate, was investigated. A number of approaches were made to recover the impurities. The residue of impurities from the methyl borate evaporation was taken up in dilute acid solution, transferred to an electrode, and excited in a high-voltage ac spark. This technique (solution transfer) was not wholly satisfactory because some of the impurities failed to get into the electrode. A technique for collecting the impurities using a getter was pursued. Yttrium oxide, germanium dioxide, and gallium oxide were used as impurity getters. Yttrium oxide provided a convenient means of collecting all of the impurities, however, since the carrier-distillation technique was necessary for the yttrium oxide matrix (yttrium has a complex spectrum) quantitative determinations were difficult because of the critical selection of internal standards. When germanium dioxide was used, intimate contact of the getter and impurities was not achieved. When gallium oxide was used, intimate contact of impurities and getter was achieved resulting in improved precision. (D.H.M.)

10257 (AERE-Trans–1057) 25 YEARS OF NUCLEAR FISSION. METHODS AND RESULTS OF CHEMICAL STUDIES. 2. METHODS. Herrmann, G. Translated by A. Crozy (Atomic Energy Research Establishment, Harwell, Eng.), from Radiochim. Acta, 4: 173-88(1965). 48p. Dep. BIS $1.40, HMSO 7s. 0d.

A review is presented on the detection of new short-lived fission products and study of mass distribution and charge distribution. Purely physical methods are discussed insofar as they apply to such problems. (168 references). (P.C.H.)

10258 (CEA-tr-R-1704) DETERMINATION DE L'ACTIVITE DU RAYONNEMENT α DES RESIDUS SOLIDES D'EAU ET DE SOL. (Determination of the α Activity of Solid Residues from Water and Soil). Zreverzheeva, V. F. Translated into French from Gig. Sanit., 26: No. 7, 69-74(1961). 12p. (In French). Dep. mn. JCL $1.60 fs, $0.80 mf.

A method for determination of the α activity of solid residues from water and soil is described. The α activities were determined in samples having a saturated layer. This saturated layer is a layer of the substance of such thickness that the α particles leaving internal layers and following the shortest path are entirely captured in the thickness of the substance. The advantages of the method are given. The difficulties of the method are outlined, and ways of overcoming these difficulties are discussed. (J.S.R.)

10259 AUTOMATED SYSTEM FOR SAMPLE COLLECTION AND COMPUTER ANALYSIS OF THIN-LAYER RADIOCHROMATOGRAMS. Snyder, Fred; Smith, Donna (Oak Ridge Associated Universities, Tenn.). Separation Sci., 1: 709-22(1966).

An automatic scraper for collecting minute zones of absorbent along thin-layer chromatographic lanes for subsequent radioisotopic or chemical measurements was combined with a direct data-acquisition system. Remotely located liquid scintillation

spectrometers transmit data by means of a dedicated telephone circuit to an IBM 026 Card Punch in a data-processing center. Programs using an IBM 7090 computer and a Benson-Lehner Electroplotter were developed, providing radiometric analysis of small (1- and 2-mm) and large TLC zones, and graphically producing exact-scaled replicas of the radioisotopic distribution along the chromatographic lanes from the punched-card data. The programmed analysis includes the conversion of cpm to dpm, the computation of the radioisotopic distribution on chromatograms, recovery of activity from TLC plates, and determination of specific activity. Application of this system of analysis is illustrated for the separation of synthetic derivatives of ^{14}C-labeled alkyl glyceryl ethers and of products of a lipase-catalyzed reaction. (auth)

10260 MEASUREMENT OF THE RADIOACTIVITY OF ORGANIC COMPOUNDS LABELED WITH ^{3}H. Starcuk, Zenon; Cupak, Miloslav (Inst. of Macromolecular Chemistry, Brno). Chem. Listy, 60: 1543-5(Nov. 1966). (In Czech).

Descriptions are given of an original method for gas-filling of a counter for recording radioactivity of organic materials labeled with ^{3}H. (tr-auth)

10261 NUCLEAR METHODS FOR DETERMINING BORON IN SILICON. Dragnev, T. N. (Inst. of Physics, Academy of Sciences, Bulgaria). Compt. Rend. Acad. Bulg. Sci., 19: 711-14 (1966). (In Russian).

The concentration of boron in silicon may be determined by a method combining the $^{10}B(n,\alpha)^{7}Li$ reaction with the sensitivity of n-p transitions in silicon toward charged particles. The number of α particles resulting from the reaction is proportional to the number of boron atoms. This method, which makes it possible to determine concentrations down to 10^{-5}%, was further improved by including a low-noise preamplifier, a spectroscopic pulse amplifier and a threshold amplifier in the system, increasing the sensitivity by a further order of magnitude. However, the method may be used only with single crystals; during the recrystallization of silicon the boron may be redistributed. To overcome this problem, thin disc-shaped specimens were used, keeping the thickness the same as the mean free path of the 0 to 1.5-MeV α particles, and recording the particles emitted at the two surfaces by means of a dual pulsed ionization chamber. A sensitivity of 10^{-6}% was obtained with polycrystalline specimens. (TTT)

10262 DETERMINATION OF FLUORITE BY ACTIVATION ANALYSIS. Bushkov, A. P.; Prokopchik, V. I. At. Energ. (USSR), 21: 215-17(Sept. 1966). (In Russian).

The activation method is widely used to determine the CaF_2 content of ores; in most cases a fast-neutron source is used for the analysis. The activation is due to fast-neutron threshold reactions and to (n,γ) reactions of thermal neutrons formed by the slowing down of the fast neutrons. Calculation of the spatial distribution of the source in an infinite, hydrogen-free medium indicated that at 20 cm from the source, the >3-MeV fast flux exceeds the thermal flux. The effective cross section of the $^{19}F(n,\alpha)^{16}N$ fast-neutron reaction exceeds that of the $^{19}F(n,p)^{19}O$ and $^{19}F(n,\gamma)^{20}F$ thermal-neutron reactions; therefore, it was assumed that the γ radiation observed is induced by fast neutrons. This problem was experimentally investigated on a mock-up, using a 5.4×10^{6} n/cm^2 Po–Be source. Although the results did not allow definite conclusions to be drawn, it appeared that the γ radiation of ^{16}N played the most important role; activation by thermal neutrons was slight. (TTT)

10263 UNIT FOR AUTOMATIC COUNTING AND RECORDING OF THE CHROMATOGRAM RADIOACTIVITY. Markelova, V. F.; Tatsievskii, V. A.; Starodub, K. Ya. Med. Radiol., 11: No. 12, 40-2(Dec. 1966). (In Russian).

An automatic radiometric unit designed for measurement and graphic registration of radioactivity in radiochromatogram patches is described. The unit can be utilized in laboratories where chromatographic (or electrophoretic) fractionation of isotopes or labeled substances is practiced. (auth)

10264 RAPID METHOD FOR DETERMINING NITROGEN IN URANIUM NITRIDES. Taylor, B. L.; Perrett, B. S. (Atomic Energy Research Establishment, Harwell, Eng.). Analyst, 92: 64(Jan. 1967).

An inert-gas fusion method for determination of nitrogen in uranium nitrides was developed. It is more rapid than the Dumas and Kjeldahl methods and is comparable with these methods with regard to accuracy and precision. The oxygen content of the sample can be obtained simultaneously. (M.C.G.)

10265 ACTIVATION ANALYSIS OF OXYGEN AT THE SURFACE OF SOLIDS. Wilkniss, P. E.; Born, H. J. (Technische Hochschule, Munich). Int. J. Appl. Radiat. Isotop., 18: 57-64 (Jan. 1967). (In German).

The possibilities for the determination of oxygen by activation analysis at the surface of solid samples were investigated using the nuclear reaction $^{16}O(t,n)^{18}F$. The decrease of the activation of oxygen in aluminum was calculated and measured. Two methods for the determination of oxygen at surfaces were investigated. One uses tritons which impinge at small angles to the surface, the other uses the recoil of the ^{18}F-atoms. (auth)

10266 ANALYSIS OF ERRORS AND ACCURACY OF SIMULTANEOUS ^{3}H AND ^{14}C ASSAY IN ORGANIC SUBSTANCES BY MEANS OF AN INTERNAL GAS COUNTER. Tykva, R. (Inst. of Organic Chemistry and Biochemistry, Prague). Int. J. Appl. Radiat. Isotop., 18: 45-56(Jan. 1967).

Accuracy was calculated and the individual procedures were studied with regard to possible sources of errors in the method using the internal gas counter for radioactivity determinations of ^{3}H and ^{14}C in double-labeled solid organic compounds. The method facilitates the preparation of a filling of constant composition and determines the relative radioactivity of the radionuclides. The procedure is designated for dry samples of up to 50 mg and is essentially unaffected by their character and composition. The method is especially suitable for the determination of low activities of both isotopes in biological material, on paper chromatograms and thin-layer chromatograms, or in substances causing considerable quenching after introduction into liquid scintillator. (auth)

10267 THE DETERMINATION OF BARIUM IN G-1 AND W-1 [ROCK STANDARDS] BY ISOTOPE DILUTION. Schnetzler, C. C.; Thomas, H. H.; Philpotts, J. A. (Goddard Space Flight Center, Greenbelt, Md.). Geochim. Cosmochim. Acta, 31: 95-6 (Jan. 1967).

Serious analytical difficulties were experienced in the determination of barium in rocks and minerals. The range of reported values in G-1 is from 900 to 3000 ppM and in W-1 from 120 to 390 ppM. Barium determinations obtained by mass spectrometric stable isotope dilution, employing ^{136}Ba, are reported. Experimental details are outlined and results tabulated. The sensitivity of barium in the thermal ionization mass spectrometer is stated to be so high that less than 1 μg of barium is needed for an analysis, although larger samples were employed for the analysis. The barium was separated chromatographically, and determined using a 12-in. 60° sector surface ionization mass spectrometer. The 134 to 138 mass range was scanned magnetically and the barium concentration in the sample calculated from the resulting mass spectrum. Results indicate a barium concentration of 1040 ± 20 ppM in G-1 and 158 ± 2 ppM in W-1. (UK)

10268 THE DETERMINATION OF ^{89}Sr IN BIOLOGICAL SAMPLES. Creger, C. R.; Ansari, M. N. A.; Couch, J. R.; Colvin, L. B. (Texas A and M Univ., College Station). Int. J. Appl. Radiat. Isotop., 18: 71-5(Jan. 1967).

A simple and sensitive method for determination of ^{89}Sr has been developed. The method consists of ashing the sample in a muffle furnace, dissolving the ash in a minimum amount of HCl, preparing solid samples on glass fiber disks, and determining the activity by liquid scintillation counting. Counting efficiencies of approximately 65% were obtained. The use of glass fiber disks has reduced the error in pipetting and has eliminated quenching. The procedure has given reproducible results and has been used successfully for quantitative determination of ^{89}Sr in various tissues, bones and eggs (shell, yolk, and albumin) from birds injected intramuscularly with $^{89}SrCl_2$. An improved and relatively accurate method for the determination of quenching, based on an internal standard, is also described. (auth)

10269 ACTIVATION ANALYSIS: A REVIEW. Coleman, R. F. (Atomic Weapons Research Establishment, Aldermaston, Eng.); Pierce, T. B. Analyst, 92: 1-19(Jan. 1967).

An attempt was made to indicate the diverse fields from which developments in technique have emanated, and to evaluate their significance. The emphasis is on work published during the past 3 years. A section briefly outlining the theoretical basis for the technique is included. Headings are as follows: nuclear interactions; irradiation facilities (nuclear reactors, accelerator neutron sources, isotopic neutron sources, charged particles, gamma photons); measurement of induced activity (radiochemical separations, rapid separations, group separations, automatic separation systems, and substoichiometry, gamma spectroscopy, other counting methods, prompt radiation techniques); and applications (high-purity materials, biology, forensic science, geochemistry, on-line analysis, surface analysis). (180 references). (UK)

10270 THE TRACE ELEMENT CONTENT OF HUMAN HEAD HAIR IN ENGLAND AND WALES AND THE APPLICATION TO FORENSIC SCIENCE. Coleman, R. F.; Cripps, F. H.; Stinison, A.; Scott, H. D. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Atom, No. 123, 12-22(Jan. 1967).

One of the more frequent investigations in a forensic science

laboratory is concerned with the problem of determining whether a particular object can be shown to come from a specified source. Hair may be found at the scene of a crime and if it can be shown to be similar to the hair of a suspect, then it establishes a link between the suspect and the place or circumstance in which it was found. Trace element analysis can assist in associating hair with a particular head. Details of studies to enable a quantitative assessment to be made of the value of this approach in forensic examinations are presented. Emphasis is on the application of neutron activation analysis. (UK)

10271 ESTIMATION OF THORIUM AND URANIUM AT THE SUBMICROGRAM LEVEL IN BONE BY NEUTRON ACTIVATION. Edgington, D. N. (Argonne National Lab., Ill.). Int. J. Appl. Radiat. Isotop., 18: 11-18(Jan. 1967).

A method for determining thorium and uranium at the submicrogram level (down to 10^{-3} μg) is described. Bone which has previously been ashed at 600°C is irradiated in a neutron flux of 2×10^{13} n cm^{-2} sec^{-1} for 20 min. After chemical separation, which involves elution from an anion exchange column using a mixture of hydrochloric and hydrofluoric acids, the induced ^{233}Pa and ^{239}Np activities were measured and compared to a standard. The method was tested using samples of ashed cow bone to which were added known concentrations of uranium and thorium, and results for the analysis of several bone samples with widely differing histories are presented. (auth)

10272 A CRITICAL REVIEW OF NEUTRON ACTIVATION AND TRACER METHODS FOR THE DETERMINATION OF THE NOBLE METALS. Beamish, F. E.; Chung, K. S.; Chow, A. (Univ. of Toronto). Talanta, 14: 1-32(1967).

Neutron activation methods for seven noble metals (Au, Ru, Os, Rh, Ir, Pd, Pt) are critically reviewed. The methods deal with determination of trace impurities in each noble metal, as well as traces of noble metals in media such as organic material, fission products, and other solutions, ores, alloys, minerals, silica and base metals. The need for confirmatory evidence in the case of such compiex materials as ores is emphasized. (auth)

10273 A NEW OXIDIMETRIC REAGENT: POTASSIUM DICHROMATE IN A STRONG PHOSPHORIC ACID MEDIUM. VII. PHOTOMETRIC TITRATION OF VANADIUM(IV) AND OF CERIUM(III) ALONE AND IN MIXTURES WITH IRON(II). Rao, G. Gopala; Rao, P. Kanta (Andhra Univ., Waltair, India). Talanta, 14: 33-43(1967).

Vanadium(IV) can be accurately titrated with potassium dichromate in media containing phosphoric acid of 3 to 12M concentration; the change in absorption of vanadium(IV) is followed in the region 660 mμ using a red filter. It is more convenient to carry out the titration in 3M phosphoric acid because at higher concentrations chloride, nitrate, cerium(III), and manganese(II) may interfere. Photometric titration is more convenient than potentiometric because the former can be carried out in a 3M phosphoric acid medium, whereas the latter is possible only in 12M phosphoric acid. The simultaneous differential photometric titration of iron(II) and vanadium(IV) is also possible. Conditions were found for the photometric titration of cerium(III) and of cerium (III) plus iron(II). The titration is carried out (at 450 mμ or with a blue filter) in about 10.5M phosphoric acid. Application of the method to a cerium mineral is considered. (auth)

10274 DETERMINATION OF RHENIUM IN MOLYBDENITE BY NEUTRON-ACTIVATION ANALYSIS. Terada, Kikuo; Yoshimura, Yukio; Osaki, Susumu; Kiba, Toshiyasu (Kanazawa Univ., Japan). Talanta, 14: 53-60(1967).

A neutron-activation method is described for the determination of rhenium in molybdenite. Radiochemical separation by a carrier technique was carried out very rapidly by means of successive liquid-liquid extraction processes. The recovery of rhenium, which was determined by a spectrophotometric method, was about 93%. About 10 samples could be analyzed within 6 hr in parallel runs. (auth)

10275 SEPARATION OF STRONTIUM FROM LARGE AMOUNTS OF CALCIUM, WITH APPLICATION TO RADIOSTRONTIUM ANALYSIS. Noshkin, Victor E.; Mott, Norman S. (Woods Hole Oceanographic Institution, Mass.). Talanta, 14: 45-51(1967). (NYO-2174-32; NYO-3145-3).

The elution first of calcium and then of strontium by complex formation with cyclohexanediaminetetra-acetic acid (CyDTA), after sorption on ion-exchange columns, is shown to require careful control of pH and the concentrations of CyDTA and NH_4^+. A procedure is described for volumetric analysis of calcium and strontium, and for use of this separation procedure before determination of ^{90}Sr in seawater. Careful choice of reagents and materials is shown to be necessary for use of such a method in determination of trace amounts of radiostrontium. (auth)

10276 SUBSTOICHIOMETRIC SEPARATION IN ACTIVATION ANALYSIS. EXTRACTION OF COORDINATIVELY UNSOLVATED SALTS. Alimarin, I. P.; Perezhogin, G. A. (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Talanta, 14: 109-19(1967).

The necessary conditions were examined for use of extraction of coordinatively unsolvated salts for substoichiometric separations in activation analysis, especially with regard to the influence of interfering ions and of the concentration of the carrier. A study was made of the substoichiometric extraction of halide ions, oxyanions, and anionic metal complexes by means of the tetraphenylarsonium ion into chloroform and dichloroethane, and of the extraction of alkali metal ions into nitrobenzene with tetraphenylborate. Substoichiometric extraction can be combined with neutron-activation analysis for determination of traces of iodine, cesium, rubidium, manganese, rhenium, chromium, thallium, gold, gallium, and tantalum. (auth)

10277 USE OF LIQUID SCINTILLATION COUNTING FOR THE DETERMINATION OF DISTRIBUTION RATIOS OF ALPHA EMITTERS. Scott, C. A.; Good, M. L. (Louisiana State Univ., New Orleans). J. Inorg. Nucl. Chem., 29: 255-7(Jan. 1967). (ORO-2576-22).

The usefulness of a liquid scintillation method for determination of the distribution of an alpha emitter in a two-phase system is shown. The distributions of ^{241}Am between hydrochloric acid solution and triisoöctylamine and of ^{233}U between nitric acid solution and triisoöctylamine were determined. The method was also applied to ^{210}Po studies. (M.C.G.)

10278 DETERMINATION OF COPPER, GALLIUM, AND ZINC IN STANDARD ROCKS BY NEUTRON ACTIVATION. Brunfelt, A. O. (Oslo Univ.); Johansen, O.; Steinnes, E. Anal. Chim. Acta, 37: 172-8(Feb. 1967).

A neutron activation method for the simultaneous determination of copper, gallium, and zinc in rocks is described. The method is based on anion-exchange separation steps and measurement of γ activity. Chemical yields were determined by re-activation. Results for a series of igneous "standard rocks" are presented. The accuracy of the mean values is ca. 5% for concentrations exceeding 10 ppM. (auth)

10279 NEUTRON ACTIVATION ANALYSIS OF HIGH PURITY SELENIUM. PART I. DETERMINATION OF BROMINE. Ballaux, C.; Dams, R.; Hoste, J. (Ghent Univ.). Anal. Chim. Acta, 37: 164-71(Feb. 1967).

Neutron activation analysis for 2 to 0.8 ppM bromine in selenium was performed by irradiating 1 g samples for 2 hr at a neutron flux of 4×10^{11} n/cm^2/sec. The bromine was separated by a double precipitation technique as silver bromide to obtain adequate decontamination and the isotope ^{82}Br ($T_{½}$ = 35.87 hr) measured. Errors due to self-shielding in the standards and flux-depression in the selenium were calculated. Measurements on 2 different photopeaks were made to avoid errors from interfering isotopes. (auth)

10280 THE DETERMINATION OF LANTHANUM, CERIUM, AND THORIUM WITHOUT SEPARATIONS. THE DETERMINATION OF LANTHANUM AND CERIUM IN THORIUM. Hiiro, K.; Russell, D. S.; Berman, S. S. (National Research Council, Ottawa). Anal. Chim. Acta, 37: 209-16(Feb. 1967).

A spectrophotometric determination of small quantities of lanthanum, cerium, and thorium in the presence of one another without separations is described. Cerium is estimated from its absorption peak in the ultraviolet region, thorium with thorin, and the 3 elements together with arsenazo. The lanthanum is calculated after subtraction of the combined absorbances of the arsenazo complexes of the thorium and cerium. The procedure can be readily applied to the determination of microgram amounts of the 2 rare earths in thorium. In this case the majority of thorium is removed from solution by solvent extraction with TTA before estimation of the rare earths. The interference of iron is considered and proposals made for its removal. (auth)

10281 ACTIVATION ANALYSIS FOR NONDESTRUCTIVE LOCALIZATION OF IMPURITIES IN FOILS. Menon, M. P.; Rainosek, A. P.; Wainerdi, R. E. (Texas A and M Univ., College Station). Nucl. Appl., 2: 335-40(Aug. 1966).

Neutron activation and scanning techniques were applied to the study of localization of impurities in aluminum foil. A mathematical model including the necessary correction factors for the measurement of the distribution ratios of the impurity in the foil is presented. The use of a shielded and collimated NaI(Tl)-CsI dual-crystal detector in scanning is demonstrated. Not only the neutron flux distribution, but also the variation in the side contributions to the localized counting of an irradiated aluminum foil, was shown to be significant for the localization of impurities. Although the results of this study are semi-quantitative, there is indication that

the copper and gallium impurities in commercial-grade aluminum foil are unevenly distributed. (auth)

10282 SPECTROPHOTOMETRIC DETERMINATION OF MICROGRAM AMOUNTS OF TECHNETIUM AS HEXACHLOROTECHNETATE IN HYDROCHLORIC ACID MEDIUM. Pozdnyakov, A. A. (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim., 20: 473-5(1965). (In Russian).

A method for the spectrophotometric determination of Tc is based on the reduction of Tc^{8+} to Tc^{4+} with concentrated HCl and measurement of the resulting extinction of the resulting $TcCl_6^{2-}$. The molar extinction coefficient is 32,000 at 338 mμ, and Beer's law is obeyed for up to 5 μg of Tc/ml. The test solution containing 0.2 to 5 μg of Tc/ml is evaporated to dryness, and the residue is heated with 7 to 10 ml of concentrated HCl for ~1 hr. HCl is added as necessary to maintain the volume. Finally the solution is evaporated to dryness, and the residue is dissolved in 5 ml of 11 to 12 M HCl. The extinction is measured in a 1-cm cell with HCl of the same concentration as a reference. The relative error is ±~3%. Up to 30 μg each of Re and Mo in the final solution does not interfere. (Analytical Abstr.)

10283 TECHNICAL AND PRACTICAL ASPECTS OF SPECTROMETRY FOR DETERMINATION OF RADIOACTIVE ISOTOPES IN MIXTURE. Danielson, B.; Delahayes, J.; Sjoestrand, U. (Univ. of Uppsala). Acta Soc. Med. Upsaliensis, 71: 173-95(1966).

Some theoretical and practical aspects of spectrometry of radioisotope mixtures are summarized with special regard to the use of the method in biology. The maximum degree of activity for analysis was obtained by recording, when possible, both particle (β) and electromagnetic (γ and x) radiation. Large numbers of impulses were rapidly recorded by using energy channels comprising a large part of the energy spectra studied. The boundaries of the energy channels were placed over such parts of the energy spectra in which the counting rate was low so that the analytical results would be minimally influenced by variations in the amplification and pulse discrimination of the apparatus. In analysis of radioisotopic mixtures the error of the method was found to be small and the recovery good. Results are highly dependent on the stability of the apparatus and the analytical conditions. The amplification system of the apparatus must be stable in time, (stable high voltage is essential) and it must be independent of the input pulse frequency. The volume and physical composition of the sample were also found to be of great importance in the analyses. On investigation of commercially available equipment it was found that the tube types were generally better than the transistorized ones. It was concluded that, provided stable equipment is used and that the analytical conditions are kept constant, the method described can be used for the analysis of radioisotope mixtures to give accurate results. (BBB)

10284 DETERMINATION OF URANIUM AND THORIUM ORES USING GAMMA SPECTROMETRY. Domingos, J. M.; Melo, A. A. (Univ. of Mozambique, Portugal). Nucl. Instrum. Methods, 48: 28-32(Feb. 11, 1967).

A radiometric method for the analysis of uranium and thorium ores is described. Three bands in the gamma spectra are selected. In the first one are counted gamma rays from 52 to 108 keV with a 1¾″ dia × ¼″ thick NaI(Tl) crystal. Gamma rays falling in the second (from 560 to 660 keV) and in the third (from 2.46 to 2.76 MeV) band are counted with a 3″ dia. × 3″ thick crystal. The method can be used for mixed uranium and thorium ores and still applies to uranium ores not in equilibrium. The method of least squares is applied to obtain the uranium and thorium concentrations, its errors and the disequilibrium factor. The calibration constants are determined with five standard samples. (auth)

10285 DETECTION LIMITS FOR COINCIDENCE METHODS IN ACTIVATION ANALYSIS. Schulze, Werner (Freie Univ., Berlin). Z. Anal. Chem., 223: 1-10(1966). (In German).

Equations of general validity were derived for the determination of the most favorable conditions in measuring a coincidence rate in presence of high-channel counting-rates having different half-lives. Diagrams are given which allow very simply to find the best counting time, the most favorable amount of the sample, and the value for the detectable coincidence rate. (auth)

10286 USE OF SUBSTOICHIOMETRIC PRECIPITATION REACTIONS IN RADIOCHEMICAL ANALYSIS. von Baeckmann, Adolf (Kernforschungszentrum, Karlsruhe, Ger.). Z. Anal. Chem., 223: 161-9(1966). (In German).

The principle of substoichiometric final precipitation in radiochemical analysis is discussed by means of the following examples: activation determination of traces of zirconium and hafnium in high-purity aluminum, and determination of fission cesium in mixtures of fission products. (auth)

10287 SPECTROPHOTOMETRIC DETERMINATION OF THORIUM IN BONE ASH USING ARSENAZO III. Petrow, Henry G.; Strehlow, Clifford D. (New York Univ., N. Y.). Anal. Chem., 39: 265-7(Feb. 1967).

Thorium was extracted from bone ash with the bis(2-ethylhexyl)-ester of phosphoric acid and then stripped from the solvent with Aliquat 336. The thorium was stripped from Aliquat 336 with hydrochloric acid, Arsenazo III was added, and the absorbance was measured. One drop of hexametaphosphate (Calgon) solution was added and the absorbance was again determined. The thorium content was obtained from a calibration curve, using the difference between the two readings as the absorbance due to thorium. From the data obtained, the thorium content of normal human bone was found to be 0.01 μg/g ash. (D.H.M.)

10288 ANALYSIS AND IDENTIFICATION OF URANIUM FLUORIDES. O'Donnell, T. A.; Wilson, P. W. (Univ. of Melbourne, Parkville, Australia). Anal. Chem., 39: 246-8(Feb. 1967).

A procedure is reported for the determination of any fluoride in the series UF_3, UF_4, U_4F_{17}, U_2F_9, UF_5, and UF_6 and can be applied to simple mixtures of uranium fluorides or to a mixture of a fluoride and an oxide fluoride. The uranium was determined by conventional methods and the null-point potentiometric titration was used for fluoride analysis. Complexing of cerium(IV) by fluoride was used to change the potential of a cerium(IV)–cerium(III) half-cell. Preliminary separation of fluoride in the sample was not necessary. The exact identity of a sample of uranium fluoride is difficult to obtain from only total uranium and total fluoride content. When a sample of U_4F_{17}, U_2F_9, or UF_5 is hydrolyzed it disproportionates to form a precipitate of UF_4 and a solution containing uranyl and fluoride ions. The ratio of uranium(VI) to uranium(IV) was used to determine the nature of the uranium fluoride. For UF_5 the ratio of uranium(VI) to uranium(IV) was 1:1; for U_2F_9 the ratio was 1:3; and for U_4F_{17} the ratio was 1:7. (D.H.M.)

10289 POLAROGRAPHY OF URANIUM BY THE CATALYTIC NITRATE WAVE. Habashi, Fathi; Thurston, George Ann (Montana Coll. of Mineral Science and Tech., Butte). Anal. Chem., 39: 242-3(Feb. 1967).

The catalytic nitrate wave was used to try to determine traces of uranium in sulfuric acid solutions. At low NO_3^- concentrations (0.0001 to 0.001M) the limiting current when plotted against the uranyl ion concentration showed an adsorption curve. At $[NO_3^-]$ = 0.01M the limiting current was a nonlinear function of uranyl ion concentration. However, under these conditions it was possible to determine uranium in this medium with reproducibility of ±5%. The half-wave potential varied with the NO_3^- concentration and at $[NO_3^-]$ = 0.1M or higher the half-wave potential became more negative and apparently coincided with the decomposition of the acid. The wave was completely distorted and was of no analytical value. The mechanism of a catalytic wave is discussed. (D.H.M.)

10290 CONTROLLED-CURRENT BIPOTENTIOMETRIC TITRATION OF URANIUM(IV) WITH IRON(III). Whiteker, Roy A.; Murphy, Donald W. (Harvey Mudd Coll., Claremont, Calif.). Anal. Chem., 39: 230-2(Feb. 1967).

A study was made using controlled-current bipotentiometry as the end-point method for the uranium(IV)–iron(III) titration. Uranium stock solution was passed through a Jones reductor producing a mixture of U(III) and U(IV). The column was rinsed with sulfuric acid and blanketed with an atmosphere of nitrogen. The two platinum indicator electrodes were conditioned prior to each titration by placing them in sulfuric acid, connecting them to a 6-volt source, and electrolyzing the solution for 45 min. The initial potential reading between the electrodes was set near the upper end of the 0 to 1400 mV scale using asymmetry control. Standard iron(III) solution was added as the titrant and potential reading remained near its initial high value until almost all of the uranium(III) was oxidized. Just before the first end point the observed potential dropped sharply, and it was necessary to wait about 3 min for it to stabilize. With each subsequent addition of titrant in the region of the first end point, a wait of about 1 min was required. The lowest value of the potential reading was taken to be the end point. Between the two end points the electrodes responded only slowly to potential changes and various waiting periods were required. Near the second end point the potential dropped slightly, and again the lowest potential reading in this region was taken to be the end point. Past the second end point the potential reading increased and achieved a steady value almost instantaneously. The standard deviation was about 0.1% for samples of 260 and 26 mg of uranium. At the 13-mg level the results were valid to within about 0.1 mg. The effects of changing variables such as sulfuric acid concentration, the use of nitrogen, the temperature, the rate of titration, and the electrode-conditioning treatment were considered. (D.H.M.)

10291 EXTRATERRESTRIAL NEUTRON ACTIVATION ANALYSIS. Hislop, J. S.; Wainerdi, Richard E. (Texas A and

M Univ., College Station). Anal. Chem., 39: 28A-30A; 32A-9A (Feb. 1967).

Techniques of neutron activation for determination of elements that are the major constituents of terrestrial and meteoritic rock types are described. The technique of 14-MeV neutron activation analysis was studied to determine if it could be used to distinguish instrumentally between various terrestrial rock types, in situ, and to develop a system that would be useful for analysis of the lunar or planetary surface in manned or unmanned exploration missions. Interferences from free nuclides other than those expected and the effects resulting from thermal neutron activation are considered. A system is described, which demonstrates an approach to the problem of analyzing large rock samples under remote operating conditions. The system, consisting of a small neutron generator and a 3 × 3-in. NaI scintillation gamma detector, was rotated about a central axis to reverse position of the generator and detector. It was concluded that the use of 14-MeV neutron activation analysis for lunar surface analysis has considerable potential but much development is required before inclusion on a space mission. (D.H.M.)

10292 DETERMINATION OF OXYGEN IN MOLYBDENUM BY ACTIVATION WITH FAST NEUTRONS. Andreev, A. V.; Barit, I. Ya.; Musaelyan, R. M.; Pronman, I. M. Zh. Anal. Khim., 21: 1453-6(1966). (In Russian).

The method of determining oxygen by activation with fast neutrons is one of the most rapid of all the methods known. One determination takes 15 to 20 min. The process of analysis can be completely automatized. The sensitivity of the method is 1×10^{-3}%; the accuracy is ±30%. (auth)

10293 RADIOACTIVATION DETERMINATION OF BISMUTH IN MINERAL MATERIAL. Lobanov, E. M.; Yankovskii, A. V. (Inst. of Nuclear Physics, Tashkent). Zh. Anal. Khim., 21: 1420-2(1966). (In Russian).

A method was developed for the radioactivation determination of bismuth in mineral powdered samples without using radiochemical methods. Bismuth is determined by measuring the α radiation from polonium accumulating in the analyzed samples on their irradiation by thermal energy neutrons in a nuclear reactor as a result of activation of $^{209}_{83}Bi$ nuclei followed by β decay of $^{210}_{83}Bi$. The method is highly selective for bismuth and can be used for bismuth determination in samples of complex composition. (auth)

10294 THE SCINTILLATION METHOD OF MEASUREMENT OF ^{32}P ON STRIP CHROMATOGRAMS. Radoszewski, Tomasz; Zelenay, Krystyna (Inst. of Nuclear Research, Polish Academy of Sciences, Swierk). Nukleonika, 11: 659-68(1966). (In Polish).

The scintillation method of measurement of radioactivity on a strip chromatogram was investigated. The paper radiochromatography under investigation was concerned with orthophosphoric acid as well as with sodium and potassium orthophosphates containing ^{32}P. Radioactive concentration of ^{32}P solutions amounts from a few up to several hundred mCi/ml. Measurement of the activity distribution on strip chromatogram was done by counting the separate pieces of the strip, which was previously cut-up. Measurement of activity of the basic chemical form and radiochemical impurities of the order of 0.1 per cent was possible owing to the proper counting parameters of the scintillation counter. The scintillation counter could also be used for simple relative measurements of radioactive concentration of ^{32}P solutions. (auth)

10295 THE SEPARATION OF CARRIER-FREE ^{54}Mn FROM IRRADIATED IRON BY REVERSED-PHASE PARTITION CHROMATOGRAPHY. Smulek, Wiktor (Inst. of Nuclear Research, Warsaw). Nukleonika, 11: 635-41(1966).

Reversed-phase partition chromatography has been applied to the separation of carrier-free ^{54}Mn from the neutron irradiated iron target. Tri-n-octylamine adsorbed onto siliconated kieselguhr was used as the stationary phase, and elution was carried out with hydrochloric and nitric acids. The procedure permits the separation of both micro- and macroamounts of both metals. (auth)

10296 RADIOACTIVATION METHOD FOR DETERMINING IMPURITIES IN SPECIALLY PREPARED SILICA. Chiotan, C.; Zamfir, I.; Curcaneanu, D. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Chim., 13: 745-6(1965). (In Rumanian).

The sample (1 g) was treated with H_2SO_4 (1 : 2) (2 ml) and HF (5 ml) in a platinum capsule, and after slight agitation the capsule was heated for 15 min on a water bath; more HF (5.5 ml) was added, and the mixture was evaporated, with continuous stirring, to a syrup with no further evolution of H_2SO_4. The residue was dissolved in water (15 ml), the solution was filtered, and the filtrate was evaporated to dryness on a water bath. The residue was sealed in a silica vial, then irradiated for 50 hr in a neutron flux of $\approx 4 \times 10^{12}$ neutrons per sq cm per sec. The γ spectrum of the product, measured after 30 days, showed two peaks, at 0.57 and 1.638 MeV, respectively, corresponding to ^{122}Sb and ^{124}Sb. The irradiated product was dissolved in very dilute HCl, and the radioactive impurities were analyzed by ascending paper chromatography, with concentrated HCl–H_2O-ethyl ether-methanol (4 : 15 : 50 : 30) as developer; the chromatogram showed peaks at R_F 0.0 (corresponding to Sb^{5+}) and at R_F 0.8 (corresponding to Sb^{3+}). (Analytical Abstr.)

10297 INORGANIC TRACE ANALYSIS. West, T. S. London, Imperial College of Science and Technology, 1966. 25p. 7s. 6d.

In an inaugural lecture, Jan. 25th, 1966, inorganic trace analysis is discussed under the following headings: absorption by molecules in solution (absorption spectrophotometry); absorption, followed by re-emission of radiation, by molecules in solution (spectrofluorimetry); absorption of radiation by atoms in flames (atomic absorption spectrophotometry); absorption followed by re-emission of radiation by atoms in flames (atomic fluorescence spectrophotometry); and some recent developments. Examples include some elements of "nuclear" significance. (UK)

10298 LIQUID METAL MONITORING APPARATUS. Eames, Anthony Rainsford; Pool, Richard Alexander Hamilton (to United Kingdom Atomic Energy Authority). British Patent 1,039,223. Aug. 17, 1966. Filed Dec. 19, 1961.

An apparatus for monitoring the oxide content of liquid metals comprises two chambers in series along a pipe through which the liquid metal is to flow, a filter in the upstream chamber to retain particulate matter borne by the metal, a cooler to lower the temperature of the liquid metal flowing through the chambers, thermometers to measure the temperature, means for measuring the electrical resistivity of the contents of the two chambers, respectively, and means to indicate the difference between the resistivity measurements. (B.L.M.)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 10764, 11171, 11172, 11284, 11299, 11313, and 12011.

10299 (ANL–7234) LABORATORY INVESTIGATIONS IN SUPPORT OF FLUID-BED FLUORIDE VOLATILITY PROCESSES. PART XII. THE MELTING-POINT DIAGRAM FOR THE SYSTEM URANIUM HEXAFLUORIDE–PLUTONIUM HEXAFLUORIDE. Trevorrow, L. E.; Steindler, M. J.; Steidl, D. V.; Savage, J. T. (Argonne National Lab., Ill.). July 1966. Contract W-31-109-eng-38. 33p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thermal analysis was used to determine melting points of UF_6–PuF_6 mixtures containing 0 to 100 mole % PuF_6. All mixtures melted at temperatures between the melting points of the pure components; neither maximum- nor minimum-melting mixtures were observed. The solid–liquid equilibria involved a continuous series of solid solutions, and the temperature–composition diagram exhibited the shape characteristic of such a series. Solidus points were observed at temperatures lower than those calculated for ideal behavior; this difference is attributed to fractional crystallization. (auth)

10300 (BMI-X-10175) THE PREPARATION AND HEAT CONTENT OF URANIUM-, PLUTONIUM-, AND NEPTUNIUM-CONTAINING MICROSPHERES FOR USE AS INTRINSIC THERMOCOUPLE FLUX PROBES. Farkas, Martin S. (Battelle Memorial Inst., Columbus, Ohio). July 21, 1966. Contract W-7405-eng-92. 19p. (SC-CR-66-2091). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Sandia Corp., Albuquerque, N. Mex.

Materials containing the fissile isotopes ^{238}U, ^{235}U, ^{239}Pu, and ^{237}Np, suitable for use in intrinsic thermocouples at fast fluxes from 10^{14} to 10^{16} neutrons per cm^2, were selected. Microspheres of the chosen alloys and oxides were prepared within a size range of 420 to 590 μ in diameter and were characterized. The nonmetallic microspheres were coated with ≈ 10 μ of tungsten to make them suitable for intrinsic thermocouple use. The heat contents of the fissionable materials were estimated or measured. (auth)

10301 (CEA-R-3092) HYDROLYSE DU PLUTONIUM TETRAVALENT. MISE EN EVIDENCE DE LA COMPLEXATION PAR DES ANIONS D'INTERET BIOLOGIQUE. (Hydrolysis of Tetravalent Plutonium. Evidence for Complexing by Anions of Biological Interest). Lutz, Michele; Metivier, Henri; Langlois, Yves (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 1966. 41p. (In French). Dep. mn.

After a literature survey of the hydrolysis of tetravalent plutonium (hydrolysis polymerization, depolymerization, anionic penetration), a study was made of the non-polymerized reaction products by solvent extraction and the polymerized ones by centrifuging.

The various anions led to the formation of colloids to a greater or lesser degree according to the tendency to form complexes with plutonium. The polyamino polycarboxylic acids and citric acid made it possible to maintain the plutonium in a soluble form at high values of the pH once the ratio Pu : chelating agent was equal to 1 : 1. (auth)

10302 (COO–1008-1) DEUTERIUM AND TRITIUM EFFECTS ON THE RATES OF ORGANIC REACTIONS. (Indiana Univ. Foundation, Bloomington. Research Div.). Dec. 1966. Contract AT-(11-1)-1008. 15p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for studies on: deuterium effects on rates of solvolysis of some secondary alkyl brosylates in trifluoroethanol–water mixtures; theoretical calculations of deuterium effects on rates of solvolysis of t-butyl chloride; α-deuterium effects on the rates of solvolysis of some substituted benzyl halides and arenesulfonates; stereochemical results of solvolysis of some optically active substituted 1-phenylethyl chlorides; and β-deuterium effects in solvolysis of 2,6-dimethylcyclohexyl brosylates. (P.C.H.)

10303 (COO–1149-79) LOW TEMPERATURE CHEMICAL THERMODYNAMICS PROJECT. Technical Progress Report No. 4, November 1965–November 1966. Westrum, Edgar F. Jr. (Michigan Univ., Ann Arbor. Dept. of Chemistry). Nov. 1, 1966. Contract AT(11-1)-1149. 23p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Facilities, instrumentation, and developments are reported for low temperature chemical thermodynamic studies on: actinide compounds and materials of nuclear energy relevance; lanthanide compounds; compounds of globular or polynuclear aromatic molecules; bicyclic globular molecules and polynuclear aromatic compounds; and other compounds including malonitrile, thallium fluoride, manganese diselenide, manganese monoselenide, triptycene ($C_{20}H_{14}$), anthracene, acenaphthene, and bisbenzene chromium, and also on sodium metal, glassy carbon, and pyrolytic graphite. (P.C.H.)

10304 (DP–1075) HIGH TEMPERATURE ADSORBENTS FOR IODINE. Progress Report, January 1965–September 1966. Milham, Robert C. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Dec. 1966. Contract AT(07-2)-1. 75p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A high-temperature coconut-shell carbon (ignition temperature ~530°C), which was developed by an American manufacturer, was shown in preliminary tests to meet specifications of the Savannah River Plant confinement system for removal of iodine. A procedure was developed to measure ignition temperature, to evaluate promising new types of activated carbon, and to evaluate the effects of variables (such as air flow, bed properties, impregnants, and plant service) on ignition temperature. Results of these evaluations and a literature survey of ignition temperature are reported. (auth)

10305 (EUR–3153.f) ETUDE THERMODYNAMIQUE SUR LE TRICHLORURE D'URANIUM DISSOUS DANS LES CHLORURES ALCALINS FONDUS. (Thermodynamic Study on Uranium Trichloride Dissolved in Molten Alkaline Chlorides). Hardy-Grena, C. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Aug. 16, 1966. 24p. (In French). Dep. mn.

The thermodynamic properties of dilute solutions of UCl_3 in NaCl were studied in the temperature range from 730 to 850°C. In this view, the partial vapor pressure of NaCl above the solution was measured by the Knudsen method and the activity coefficients of NaCl and UCl_3 calculated. The dilute solutions of UCl_3 in NaCl do not behave ideally; UCl_3 exhibits positive deviations from Raoult's law in NaCl. This fact would point out the formation of complex anions in the melts. (auth)

10306 (GAMD–7347) LONS: A COMPUTER CODE FOR CALCULATING DIFFUSION COEFFICIENTS. Drake, J. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Sept. 7, 1966. Contract AT(04-3)-633. 23p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

LONS- a computer code for calculating diffusion coefficients is described as it existed on Sept. 7, 1966. The code has been in continuous development for one year and in its presented form has been applied successfully to various problems. Results are given from studies of strontium-85 diffusion in pyrolytic carbon and thorium diffusion in graphite. (W.D.M.)

10307 (IS-T–135) HYDROLYSIS PRODUCTS OF RARE-EARTH SILICIDES. Clyde, Dale Dean (Ames Lab., Iowa). Nov. 1966. Contract W-7405-eng-82. 102p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The silicides, La_5Si_3, Ce_5Si_3, Pr_5Si_3, Nd_5Si_3, Gd_5Si_3, Dy_5Si_3, and Er_5Si_3, were prepared by direct combination of the elements in an arc melter under an atmosphere of argon. They were hydrolyzed with 6N H_3PO_4. In all of the reactions monosilane (95 mole percent or more) and disilane (5 mole percent or less) were produced. Trisilane was formed by the hydrolysis of La_5Si_3, Ce_5Si_3, and Nd_5Si_3 but it was not observed for the hydrolysis of Pr_5Si_3, Dy_5Si_3, Gd_5Si_3, and Er_5Si_3. No tetra- or pentasilane was produced in any of the reactions. The hydrolytic reactions for Ce_5Si_3 were studied as a function of the acid concentration. When Ce_5Si_3 was hydrolyzed with water, 2, 8, or 10N H_3PO_4, only monosilane and disilane were formed. For 4 and 6N H_3PO_4, trisilane was also observed. The silanes were separated by means of a gas chromatograph and identified with a mass spectrometer. In order to calculate a more accurate value for the number of moles of silanes from the area of the chromatogram peaks, the sensitivity factors (relative molar responses) of the chromatograph detector were determined. The values for the relative molar responses for monosilane and disilane were 52.7 ± 5.6 and 105.5 ± 12.2, respectively (benzene = 100). The relative molar response for trisilane was estimated from the relative molar responses of monosilane and disilane to be 159. (auth)

10308 (IS-T–136) A STUDY OF THE SURFACE REACTIONS OF HYDROCARBONS ON TUNGSTEN BY FIELD ELECTRON EMISSION MICROSCOPY. Gardner, Nelson Craig (Ames Lab., Iowa). Nov. 1966. Contract W-7405-eng-82. 137p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The chemisorption and surface reactions of acetylene and ethylene on tungsten surfaces were studied by field electron emission microscopy. These investigations were conducted in a liquid helium cryostat so that surface reactions could be studied from 4°K to higher temperatures under ultrahigh-vacuum conditions. Acetylene chemisorbed associatively on tungsten at temperatures below 300°K. At higher temperatures, decomposition reactions occurred and were monitored by measuring the surface work function change. The activation energy for the decomposition reaction was found to be coverage dependent. From the work function data, the relative surface concentrations of the carbon residues, hydrogen, and acetylene were obtained as functions of temperature. From shadowing experiments, it was confirmed that the chemisorbed acetylene and ethylene are immobile. However, at temperatures between 70 and 100°K, Type I diffusion was observed and offered some interesting insights to the mode of chemisorption of these hydrocarbons. It was deduced that acetylene chemisorbs "cis", with the tungsten carbon atoms coplaner, on the short 2.74 and 3.16Å spacings available on a tungsten lattice. Ethylene was found to chemisorb on the long 4.47 Å spacings available principally on the 112 and 111 planes of tungsten. It was proposed that ethylene chemisorbed "trans" to accommodate the long spacing. This bonding mode was found to account for a number of surface reactions involving ethylene that were not previously understood. From a knowledge of the surface species of ethylene and acetylene as a function of temperature and the mode of chemisorption of the two gases, a reaction mechanism for the hydrogenation of ethylene was proposed as follows: $C_2H_4(g) \rightarrow C_2H_4$; $C_2H_4 \rightleftharpoons C_2H_2 + 2H$; $C_2H_4(g) + C_2H_4 \rightarrow C_2H_6(g) + C_2H_2$; $H_2(g) + C_2H_2 \rightarrow C_2H_4$; and $C_2H_2 \rightarrow C_2 + 2H$. This mechanism accounts for a variety of observations from exchange experiments and volumetric studies of the reaction. (auth)

10309 (K–1680) METHOD OF USING A POROUS MEDIUM TO DETERMINE THE COEFFICIENTS OF VISCOSITY FOR BROMINE TRIFLUORIDE. Selby, T. W. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Jan. 13, 1967. Contract W-7405-eng-26. 35p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Experimental evaluations have been made of a porous-medium method for determining relative coefficients of viscosity for corrosive and noncorrosive gases. The apparatus and operating procedure are described in detail. Measurements of the coefficients of viscosity for argon were made over the temperature range of 35 to 200°C and are given by the equation, η, micropoise = $22.14\sqrt{T,°K} - 157.9$. Measurements of the coefficients of viscosity for bromine trifluoride were made over the temperature range of 130 to 200°C and are given by the equation, η, micropoise = $21.33\sqrt{T,°K} - 230.2$. From these data, the force constants for the Lennard-Jones (6-12) potential for bromine trifluoride were calculated to be, ϵ/k = 595°K and σ = 4.04 A. (auth)

10310 (K–1684) SENSITIVE PNEUMATIC BRIDGE POWDER ANALYZER. Weber, C. W.; Kuehn, P. R. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Jan. 11, 1967. Contract W-7405-eng-26. 27p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A rugged, but sensitive, instrument for the rapid determination of true density of a powder was developed, based on the pneumatic measurement of the true volume of a weighed sample. Transfer of air from a high-pressure chamber to the sample chamber gave an equilibrium pressure that was an indirect measure of the sample volume. A differential pressure transmitter measured the

equilibrium pressure relative to that in a parallel, reference transfer system. The bridge design increased analytical sensitivity, minimized temperature effects, and compensated for fluctuations in initial pressures. Analytical sensitivity was readily varied for different sample types. Composition of binary powder mixtures were directly determined within three minutes. The instrument provided volume measurements with a standard deviation of ±0.015 cc, yielding true density measurements of handbook quality. (auth)

10311 (KFK-431) UNTERSUCHUNGEN IN DEN SYSTEMEN ALKALIFLUORID-LANTHANIDEN/ACTINIDENFLUORID (Li, Na, K, Rb-La, S.E., Y/Np, Pu, Am). (Investigations in the System Alkali Fluoride-Lanthanide/Actinide Fluoride (Li, Na, K, Rb-La, Rare Earths, Y/Np, Pu, Am)). Schmutz, Hermann (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). July 1966. 73p. (In German). Dep. mn.

Solid state reactions of Li, Na, K, and Rb fluorides with lanthanide and actinide (III/IV) fluorides in $HF-H_2$ or $HF-O_2$ current were studied. LiF reacts with the trifluorides of the elements Eu to Lu with formation of $LiF \cdot MF_3$. In the interaction of LiF with the trifluorides of La to Sm and Tm and Am no reaction was observed; in the reaction NaF with MF_3 (M = La, rare earths, Y, Pu, and Am) hexagonal crystallizing compounds of the type $NaF \cdot MF_3$ occur; in the heavy lanthanides (Er to Lu) cubic double fluorides of the type $NaF \cdot MF_3$ and $5NaF \cdot 9MF_3$ could be detected. Both cubic type compounds form a continuous mixed crystal series. In the systems $KF-MF_3$ (M = La, rare earths, Pu, and Am) several compound types occur. In the reaction conditions used in the $MF-NpF_3$ system where M = Li, Na, and K in H_2 current or vacuum and NpO_2 + MF in H_2-HF current at 450 to 650°C, no double fluorides with trivalent Np were obtained, but compounds with tetravalent Np were observed although NpO_2 in $HF-H_2$ current at 550°C easily reacts to NpF_3. For the system $KF-NdF_3$ and for the KF-rich side of the $KF-ErF_3$ system phase diagrams were formulated. Various tertiary fluorides of the tetravalent Np and Pu with alkalies could be prepared by solid state reactions. The compound classes occurring are the tetragonal or rhombohedric $7MF \cdot 6MF_4$ and the hexagonal $2NaF \cdot MF_4$. Data on lattice constants are tabulated. (P.C.H.)

10312 (NP-16467) ETUDE DES CARBONATES D'URANYLE. (Studies of Uranyl Carbonates). Tsymbal, C. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). June 1965. 12p. (In French). Dep. mn.

The phase diagram of $Na_2CO_3 \cdot UO_2CO_3 \cdot H_2O$ was determined by taking into consideration the existence of the dicarbonate complex as a solid phase. Samples were prepared whose initial UO_2CO_3/Na_2CO_3 ratio varied from 0 to infinity. These samples were agitated for three to five weeks in order that equilibrium might be obtained. Na, U, and CO_2 were then determined in the liquid and solid phases. The ternary diagrams obtained showed, for the tricarbonates, a solubility curve almost identical to that of the diagram obtained by Blake. The region of existence of the dicarbonate complex was very narrow and corresponded to a high solubility of this complex. (tr-auth)

10313 (ORNL-TM-1683) VAPOR-LIQUID EQUILIBRIA OF THE BINARY SYSTEM URANIUM HEXAFLUORIDE-NIOBIUM PENTAFLUORIDE. Pitt, Woodrow Wilson Jr. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 136p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis. Submitted to Tennessee Univ., [Knoxville].

The vapor-liquid equilibria of the binary system uranium hexafluoride-niobium pentafluoride were investigated. Experimental data on the isothermal dependence of total pressure and liquid phase compositions at 150°C and the isobaric dependence of boiling point on liquid composition at 5.92 atmospheres were obtained. The liquid phase concentrations ranged from 2 to 70 mole percent uranium hexafluoride. The results showed that the binary system exhibits large positive deviations from Raoult's law but does not have an azeotrope between 2 and 99.5 mole percent uranium hexafluoride (and probably does not have an azeotrope at all). The activity coefficients, corrected for nonideal vapor phase behavior may be calculated from the van Laar simplification of the four-suffix Wohl equations using the constants: $A = 0.739-314\,[(1/T)-0.00236]$, $B = 1.170-574\,[(1/T)-0.00236]$, and $D = 0.239$. The critical constants of niobium pentafluoride were determined experimentally to be: $T_c = 737°K$, $P_c = 62$ atmospheres, $\rho_c = 1.21$ g/cm^3, and $z_c = 0.158$. A useful technique to correlate indirect vapor-liquid equilibrium data with various simplified forms of the Wohl equation was developed which does not require the assumption of an ideal vapor phase. The technique uses a high-speed digital computer and a modification of an existing computer program to fit the experimental data by the method of least squares to an equation or system of equations containing up to eight arbitrary constants. (auth)

10314 (ORO-2907-16) MASS SPECTROMETRIC STUDIES OF SCANDIUM, YTTRIUM, LANTHANUM, AND RARE-EARTH FLUORIDES. Zmbov, K. F.; Margrave, J. L. (Rice Univ., Houston, Tex. Dept. of Chemistry). Oct. 1966. Contract AT(40-1)-2907. 58p. (CONF-660907-7). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Chemical Society Meeting, New York.

A review is presented of recent mass spectrometric studies of the sublimation and vaporization processes for the rare earth trifluorides. In all cases, the vapors over condensed rare earth trifluorides are the monomeric MF_3 molecules. The rates of sublimation of the trifluorides were measured and the heats of sublimation determined by the second-law method. Mono- and difluorides of the rare earths may be produced in the vapor phase either by vaporizing the trifluorides under reducing conditions, or by oxidizing the rare earth metals with a fluorinating agent. Ionization potentials for rare earth atoms, mono- and difluorides were measured by the electron-impact method. Gaseous equilibria involving the atoms, sub-fluorides, and tri-fluorides of the various metals were studied and used to establish the bond strengths and other thermodynamic properties. The dissociation energies of the rare earth monofluorides show a correlation with atomic number, similar to that observed for the dissociation energies of monoxides and the heats of sublimation of the metals. (auth)

10315 (ORO-3508-1) THE EFFECT OF RADIATION AND GAS CONCENTRATION ON RARE GAS DIFFUSION IN SOLIDS. Annual Progress Report, March 1, 1966-November 7, 1966. Elleman, Thomas S. (North Carolina State Univ., Raleigh. Dept. of Nuclear Engineering). Contract AT(40-1)-3508. 31p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Techniques for preparing single crystals of CsI doped with radioactive ^{133}I were developed, and a number of tagged crystals were prepared. Following decay of ^{133}I to radioactive ^{133}Xe, crystals were heated at temperatures ranging from 200 to 500°C, and the rate of gas release measured by assay of the ^{133}Xe outside the specimens. The kinetics of gas release agreed with classical diffusion mechanisms, and a single activation energy for diffusion of 23 kcal/mole was observed. Crystals grown rapidly yielded x-ray diffraction patterns showing high internal stresses, and these crystals yielded the burst type gas diffusion behavior characteristically observed in fission gas release studies with reactor fuels. The true diffusion coefficient for these crystals was identified with the initial rapid release during the burst rather than with the slower gas release at long heating times. Preliminary experiments where the ^{133}Xe was produced by fast neutron transmutation of ^{133}Cs also gave classical diffusion kinetics, but the diffusion coefficients were lower than those obtained in the ^{133}I doping experiments. Results to date are consistent with a model where gas atoms are trapped during diffusion at defects produced during crystal growth or fast neutron irradiation and later released from the defects to diffuse through the lattice. (auth)

10316 (PA-TR-3388) COMPILATION OF NEUTRON SPECTRA OF SOLIDS AND LIQUIDS. Boutin, H. P.; Prask, H. J.; Trevino, S. (Picatinny Arsenal, Dover, N. J. Feltman Research Labs.). Dec. 1966. 163p. CFSTI $3.00 cy, $0.65 mn.

A compilation of the neutron spectra of 116 organic and inorganic substances taken with the slow chopper time-of-flight spectrometer is presented. A short review of neutron scattering theory is given, followed by a description of the experimental setup. Some characteristics of the samples studied and the various vibrational frequencies obtained for each sample are assembled in 28 tables. The figures represent the neutron spectra plotted on a time-of-flight basis and/or the frequency distribution extracted from the corresponding neutron spectrum. (auth)

10317 (TID-23439(Vol.1)) DESIGN STUDY OF HYDROGEN PRODUCTION BY ELECTROLYSIS. VOLUME I. Final Technical Report, March 1-June 30, 1966. (Allis-Chalmers Mfg. Co., Milwaukee, Wis. Space and Defense Sciences Dept.). Oct. 1966. Contract W-7405-eng-26; Subcontract No. 2676. 54p. (ACSDS-0106643(Vol.1)). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Oak Ridge National Lab., Tenn.

The design study of hydrogen production by electrolysis, was centered around low capital investment as the primary goal, with other factors, such as high efficiency, long life, simple, trouble-free operation, maintenance and down time also influencing the conceptual system. Only uncatalyzed porous nickel electrodes were considered. Two electrolysis plant sizes were considered during the conceptual phase of the study: 4,400 pounds of hydrogen per hour (equivalent to 300 tons of ammonia per day) and 44,000 pounds of hydrogen per hour (equivalent to 3,000 tons of ammonia per day). The hydrogen is to be delivered at 3,000 psig directly to an ammonia plant. Preliminary estimates made early in the program comparing low pressure (300 psig) and high pres-

sure (3,000 psig) electrolysis plants indicated that high-pressure system capital costs would be economically unattractive; all subsequent systems studied were at 300 psig. Three hydrogen plants were studied in this program and cost estimates were prepared for their total installation and operation. The plants were evaluated as to their subsystems and the costs for all their components. The total installed costs of the three plants are: 4,400 pounds hydrogen per hour, 800 ASF, $5,469,000; 4,400 pounds hydrogen per hour, 1,600 ASF, $4,519,000; and 44,000 pounds hydrogen per hour, 1,600 ASF, $37,540,000. These are "battery limit" costs, including modules, process and electrical equipment, compressors, controls and structures, but excluding auxiliaries, such as administration buildings, cafeteria, etc. Annual operating costs for these same plants amount to $1,635,700, $1,818,100, and $16,121,000, respectively. Power requirements are 99,000, 111,000, and 1,009,000 kw, or 22.5, 25.2, and 25.2 kwh per pound of hydrogen. A test module, designed to operate at the conditions recommended for full scale units, was constructed as part of the program. Testing was started late in the program, and discontinued after a short time due to nickel-to-stainless galvanic corrosion. Electrical separation of dissimilar metals is expected to alleviate this problem. In consideration of the economics of the electrolysis process, it is recommended that a subscale prototype plant be designed, built, and tested under actual production conditions. (M.C.G.)

10318 (TID-23439(Vol.2)) DESIGN STUDY OF HYDROGEN PRODUCTION BY ELECTROLYSIS. VOLUME II. Final Technical Report, March 1–June 30, 1966. (Allis-Chalmers Mfg. Co., Milwaukee, Wis. Space and Defense Sciences Dept.). Oct. 1966. Contract W-7405-eng-26; Subcontract No. 2676. 171p. (ACSDS-0106643(Vol.2)). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Oak Ridge National Lab., Tenn.

Drawings, preliminary specifications, and cost estimates for the electrolytic production of hydrogen are presented. (M.C.G.)

10319 (UCRL-50145) SOME NEW THERMOPILE-TYPE RADIOMETRIC CALORIMETERS. Gunn, Stuart R. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 12, 1966. Contract W-7405-eng-48. 22p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Three radiometric calorimeters of varying sizes and sensitivities are described. All are of the twin steady-state heat-flow type, employing multi-junction thermopiles as the sensing elements. Two of these were extensively tested and compared with two older resistance-bridge calorimeters by use of two ^{238}Pu capsules, which were also accurately measured at another laboratory. (auth)

10320 (UCRL-Trans-10080) ABSORPTION AND EMISSION SPECTRA OF ZnS AND CdS CRYSTALS AND THEIR ARRANGEMENT IN HYDROGEN-LIKE TERM SYSTEMS. Broser, I.; Broser-Warminsky, R. Translated by F. D. Jones (Univ. of California Lawrence Radiation Lab., Livermore), from Z. Elektrochem., 61: 209-20(1957). 92p. Dep. mn. JCL $8.60 fs, $2.96 mf.

The optical and electrical properties of individual synthetic single crystals of ZnS and CdS were studied in detail at various temperatures. In addition to the absorption and emission spectra, the excitation, quenching, and stimulation spectra were also recorded, and where possible the luminescence and photoconductivity of the substances in question were also measured. It is possible to arrange many of the bands observed into a scheme, if it is assumed that the absorption and emission processes take place predominantly inside the irregularities. Hydrogen-like term systems are then obtained for Cu-activated crystals within the "forbidden" zone of the band model, the transitions between the various energy levels corresponding to the experimentally observed band maxima. (auth)

10321 INFRARED SPECTRA OF ISOTOPIC HYPONITRITE IONS. McGraw, G. E.; Bernitt, D. L.; Hisatsune, I. C. (Pennsylvania State Univ., University Park). Spectrochim. Acta, 23: 25-34(Jan. 1967).

The infrared spectra of hyponitrite ions containing ^{14}N and/or ^{15}N were obtained by the KBr disc and Nujol mull techniques. One infrared fundamental assigned earlier to this ion was found to belong to water, but a fundamental was observed beyond the spectral range studied previously. Frequencies of the fundamentals were assigned and confirmed by normal coordinate analysis. Some infrared data on isotopic hyponitrous acids were obtained. The acid appears to have a C_{2h} symmetry in the solid state. (auth)

10322 CATALYTIC DEUTERIUM EXCHANGE REACTIONS WITH ORGANICS. XXVII. THE ALKYLBENZENES ON SELF-ACTIVATED GROUP VIII TRANSITION METALS. Fisher, B. D.; Garnett, J. L. (Univ. of New South Wales, Kensington, Australia). Austral. J. Chem., 19: 2299-2316(Dec. 1966).

Exchange reactions between heavy water and the alkylbenzenes were investigated on the following self-activated Group VIII transition metal oxides: $PtO_2.2H_2O$; PdO; Rh_2O_3; $IrO_2.2H_2O$; $RuO_2.H_2O$; ReO_2; and Ni_2O_3. All oxides except Ni_2O_3 are self-activated by benzene up to 180°. Order of ease of self-activation is Pt > Pd > Rh, Ru, Ir > Re > Ni. Trends in deuteration rates of the alkylbenzenes on self-activated platinum oxide are generally similar to those obtained on hydrogen prereduced platinum. At 130°, some differences in reactivity were observed and these were attributed to reagent displacement effects from the presence of small percentages of dimer (1%) associated with the self-activation process. Compared with hydrogen prereduced catalysts, significant differences in isotope orientation were observed with certain alkylbenzenes on self-activated catalysts. Multiple deuteration effects which were accentuated on self-activated catalysts were used to confirm isotope orientation and also the participation of a π-complex mechanism for the exchange process. Isomerization and exchange in cis- and trans-stilbenes on self-activated platinum were interpreted by the dissociative π-complex substitution mechanism. The advantages of self-activated catalysts in general deuterium and tritium labeling work were evaluated. Possible correlations between exchange results and electron spin resonance data for charge-transfer adsorption on the above oxides are discussed. Preliminary kinetic studies with self-activation are also reported. (auth)

10323 REACTIVITY IN NUCLEOPHILIC SUBSTITUTION. PART II. KINETICS AND MECHANISM OF THE HYDROLYSIS OF 9-FLUORENYL TOLUENE-P-SULPHONATE IN AQUEOUS ACETONE. Cowell, G. W.; George, T. D.; Ledwith, A.; Morris, D. G. (Univ. of Liverpool). J. Chem. Soc. (London), B, No. 12, 1169-72(1966).

The hydrolysis of 9-fluorenyl toluene-p-sulfonate has been studied in various aqueous-organic solvents. In 90% aqueous acetone there was a linear relation between the specific rates of hydrolysis and the concentration of added $LiClO_4$ or NaBr. For the same solvent the alpha deuterium kinetic isotope effect $k_H/k_D = 1.14$. Increasing the water content of the solvent increased the rates of hydrolysis and all these observations were taken to substantiate a classical S_N1-type reaction for the rate-determining process. (auth)

10324 TRACER STUDIES OF CARBOXYLIC ACIDS. PART V. ACETIC ACID IN CONCENTRATED SOLUTIONS OF MINERAL ACIDS. O'Connor, Charmian; Turney, T. A. (Univ. of Auckland, N. Z.). J. Chem. Soc. (London), B, No. 12, 1211-17(1966).

The exchange of the oxygen atoms of acetic acid with water, in concentrated solutions of hydrochloric, sulfuric, and perchloric acid, is described. The change in rate caused by the addition of high concentrations of phosphoric acid and of lithium salts to the reaction medium has also been observed. A mechanism consistent with all the experimental results has been postulated. (auth)

10325 INTERACTION OF URANIUM(IV) WITH CHLORIDE–FLUORIDE MELT NaCl–KCl–NaF. Smirnov, M. V.; Koryushkin, A. P.; Komarov, V. E. At. Energ. (USSR), 21: 476-8(Dec. 1966). (In Russian).

Redox measurements of U(III) and U(IV) potential were used in the analysis of reactions of tetravalent uranium with chloride–fluoride melts. The measurements were carried out in an equimolar potassium chloride–sodium chloride melt mixture containing 3 wt % U and 8.0 to 18.5 wt % NaF, at 973 to 1123°K. In the investigated melt mixture, U(IV) formed a complex fluoride UF_7^{3-}. The temperature dependence of instability constants of the complex in the NaCl–KCl–NaF melt is expressed by the expression: $\lg K = 0.95 - (16200/T) \pm 0.25$. (tr-auth)

10326 CONDITIONS OF PRECIPITATION OF URANIUM FROM HYDROTHERMAL SOLUTIONS BY DISULPHIDE METALS. Osipov, B. S. At. Energ. (USSR), 21: 479-83(Dec. 1966). (In Russian).

It was found that pyrite and molybdenite are effective materials for hexavalent uranium reduction from uranyl sulfate at high temperatures. The reduction and precipitation of uranium were achieved in very dilute solutions. The temperature and pH of the media influenced the efficiency of the process. Considerable concentration of U(VI) was left in equilibrium with disulfide solutions. Various impurities in pyritic ore of various deposits did not influence the equilibrate concentration of uranium in solution. (tr-auth)

10327 SOME THERMODYNAMIC STABILITY DATA ON URANINITES WITH VARIABLE COMPOSITION IN SUPERGENE CONDITIONS. Drozdovskaya, A. A.; Melnik, Yu. P. At. Energ. (USSR), 21: 483-92(Dec. 1966). (In Russian).

Thermodynamic studies of stability fields of uraninites with various oxygen coefficients in pure water were made at 20°C and atmospheric pressure. Ionic solubility of uraninites in aqueous

solutions without complexing ions was studied at various pH values. Various forms of uranium in solutions and stability of anhydrous and hydrated uranium oxides are discussed and various conditions of uranium migration and precipitation from natural aqueous solutions in the hypergenesis zone are analyzed. (tr-auth)

10328 ELECTRODEPOSITION OF ^{99}Tc FROM AQUEOUS SOLUTION. Voltz, Roger E.; Holt, M. L. (Univ. of Wisconsin, Madison). J. Electrochem. Soc., 114: 128-31(Feb. 1967).

A study was made to determine the optimum conditions necessary for the electrodeposition of macro amounts of technetium (^{99}Tc) from an aqueous bath containing about 0.018 mole of NH_4TcO_4 and 1 mole of $(NH_4)_2SO_4$ per liter of solution with H_2SO_4 added to pH about 1. Electrolysis of this solution at 1 to 2 amp/dm^2 and room temperature produced a bright, metallic appearing deposit of Tc with a cathode current efficiency (CCE) of up to 30%. Included in this study are the effects on CCE of such factors as current density, bath pH, concentrations of the various reagents, temperature, and the colored cathode reduction product. Tests made to determine the nature of the deposit showed it to be essentially metallic; however, annealing was necessary to produce metallic crystals. During electrolysis a light pink reduction product formed in the bath; as electrolysis continued this reduction product became darker and appeared to poison the bath. Addition of small amounts of H_2O_2 to the bath during electrolysis prevented the colored reduction products from forming. (auth)

10329 LOW FREQUENCY MOLECULAR MOTIONS OF UREA BY NEUTRON SCATTERING SPECTROSCOPY. Badger, E. O.; White, J. W. (Physical Chemistry Lab., Oxford). Chem. Commun., No. 2, 74-6(1967).

Application of neutron scattering spectroscopy to urea is described. Slow neutrons moderated in liquid hydrogen were employed. When scattered by polycrystalline urea at 30°K the most important inelastic process is energy gain from the quantized molecular modes of the lattice. Different neutrons in the incident monoenergetic group generally gain different amounts of energy from the various modes of the sample, and the outgoing neutrons have energies that fall into several groups whose energies differ from one another by molecular energy state differences. The spectra of urea and perdeuterourea showed well resolved inelastic scattering bands, which are depicted. The results demonstrate the usefulness of the technique for studying the low energy region of the spectrum and indicate that new information is likely to result from angular dependence studies. (UK)

10330 MAGNETIC SUSCEPTIBILITY OF URANIUM TRIFLUORIDE IN THE RANGE 2 TO 300° K. Berger, Michael; Sienko, M. J. (Cornell Univ., Ithaca, N. Y.). Inorg. Chem., 6: 324-6(Feb. 1967).

The magnetic susceptibility of UF_3 was measured by the Gouy method over the temperature range from 1.9 to 300°K. Behavior followed the Curie–Weiss law $\chi = C/(T-\theta)$ with $\theta = -110 \pm 5°$. The effective moment was 3.67 ± 0.06 BM, corresponding closely to a $5f^3$ configuration. There was no sign of a Néel inversion even at the lowest temperature reached. Comparison of data for UF_3, UCl_3, and UBr_3 suggested that the ratio of spin-orbit coupling to ligand-field splitting increases in the order UF_3, UCl_3, UBr_3. (auth)

10331 NEUTRON-SCATTERING STUDY OF THE MOTIONS OF WATER MOLECULES IN HYDRATED SALTS OF TRANSITION METALS. Rush, J. J.; Ferraro, J. R.; Walker, A. (Argonne National Lab., Ill. National Bureau of Standards, Washington, D. C.). Inorg. Chem., 6: 346-51(Feb. 1967).

The low-frequency motions of water molecules in a series of hydrated transition metal salts were investigated by the energy-gain scattering of cold neutrons. The compounds studied include $CuSO_4 \cdot H_2O$, $CuSO_4 \cdot 5H_2O$, $Co(NO_3)_2 \cdot 2H_2O$, $Co(NO_3)_2 \cdot 6H_2O$, $Cu(NO_3)_2 \cdot 3H_2O$, and $UO_2(NO_3)_2 \cdot 6H_2O$. Broad bands observed in the spectra at neutron energy gains of 500 to 800 cm^{-1} were assigned to the wagging and rocking modes of the coordinated and hydrogen-bonded water molecules. Bands around 400 to 500 cm^{-1} were attributed both to $M-OH_2$ stretching modes and to the H_2O torsional vibrations around the bisectrix. Maxima were also observed at energy transfers below 300 cm^{-1}, which were tentatively assigned to hydrogen-bond stretching vibrations and possibly to $H_2O-M-OH_2$ deformation modes. Comparison of the various spectra indicated that the average strength of binding of the water molecules did not change significantly in proceeding from the higher to the lower hydrates. The neutron results are compared in detail with previous infrared and structure results. (auth)

10332 HIGH FREQUENCY TITRATION METHODS IN THE INVESTIGATION OF COMPLEX FORMATION. Ryabchikov, D. I.; Zarinskii, V. A. (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Talanta, 14: 133-6(1967).

It was found that the high frequency titration (HFT) method gives valuable information about the processes of complex formation in solutions, if the titration is carried out under conditions that give the steepest characteristic curve with the equipment used. Under these conditions break points are obtained on the titration curve at certain molar ratios of metal and complexing agent, and correspond to sharp changes in the electric conductivity of the solution as a result of such reactions as displacement of metal ions from their EDTA complexes by addition of protons. This application of HFT must be supplemented by a parallel study based on preparative work and physico-chemical methods such as potentiometry, chromatography, optical activity, etc. Applications to thorium, indium, plutonium and boron complexes are described. (UK)

10333 SPECTRAL STUDIES OF THE RARE EARTH COMPLEXES OF THE TYPE $M(NO_3)_3.3TBP$. Ferraro, J. R.; Cristallini, C.; Fox, I. (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 29: 139-48(Jan. 1967).

Rare earth nitrate-tri-n-butyl phosphate (TBP) complexes were prepared and studied by infrared and Raman techniques. Raman polarization studies provided information as to the type of coordinated nitrate involved in these complexes. Far infrared results are discussed. (auth)

10334 MOLAR VOLUMES IN THE LiF–ThF_4 SYSTEM. Hill, D. G.; Cantor, S.; Ward, W. T. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Inorg. Nucl. Chem., 29: 241-3(Jan. 1967). (ORNL-P-2167).

Density measurements in the LiF–ThF_4 system were undertaken to determine if molar volumes and expansivities also manifest strong interactions. From the phase diagram of this system and appropriate thermochemical information it may be shown that negative deviations in activity coefficients exist (e.g., the activity coefficient of LiF equals 0.49 at 77 mole % LiF and at 568°C). (UK)

10335 ADSORPTION OF ASTATINE ON PLATINUM FROM NITRIC ACID SOLUTIONS. Norseev, Yu. V.; Chao, Tao-nan; Khalkin, V. A. Radiokhimiya, 8: 497-504(1966). (In Russian).

It was established that astatine is spontaneously precipitated on platinum, covered with an oxide film, from nitric acid solutions (≫ 1M) containing bichromate solutions; increase of the temperature positively affects the adsorption of astatine on platinum; the adsorption is directly proportional to the surface of the platinum and the time of precipitation and inversely proportional to the volume of the solution and the acidity. The ions Tl^-, Hg_2^{2+}, Bi^{3+} (probably BiO^+, and Cl^-) interfere with this process. In the last case, negative chloride complexes of astatine cations $[(AtX)Cl_2]^-$ with $K_2 = 1.35 \times 0.13 \times 10^{-6}$ M^2 were formed. The precipitation of astatine on platinum from nitric acid solutions with subsequent anode dissolution can be used for resolving various problems. (tr-auth)

10336 INVESTIGATION OF THE COMPLEX FORMATION OF CURIUM AND EUROPIUM BY THE EXTRACTION METHOD. Stary, I. Radiokhimiya, 8: 509-13(1966). (In Russian).

The extraction constants of curium (log K = −7.30 ± 0.02) and europium (log K = −7.18 ± 0.03) with 4,4,4-trifluoro-1-(2-thienyl)1,3-butanedione in benzene solvent were determined. The composition and stability constants of the complexes of curium and europium with tartaric (log β_2 = 6.84 ± 0.03 for Cm and log β_2 = 6.79 ± 0.03 for Eu), oxalic acid (log β_2 = 8.8 and log β_3 = 12.1 for Cm and Eu), nitrilotriacetic acid (log β_2 = 20.13 ± 0.03 for Cm and log β_2 = 20.42 ± 0.02 for Eu), ethylenedinitrilotetraacetic acid (log β_1 = 17.10 ± 0.04 for Cm and log β_1 = 17.34 ± 0.02 for Eu), and 1,2-dicyclohexylenedinitrilotetraacetic acid (log β_1 = 18.35 ± 0.03 for Cm and log β_1 = 18.51 ± 0.03 for Eu). It was shown that the stability of the curium complexes is greater than the stability of the analogous americium complexes but less than the stability of the corresponding europium complexes. (tr-auth)

10337 COMPLEX FORMATION OF NEPTUNIUM(IV) WITH NITRATE AND CHLORIDE IONS. Shilin, I. V.; Nazarov, V. K. Radiokhimiya, 8: 514-19(1966). (In Russian).

The complex formation of tetravalent neptunium with nitrate and chloride ions was investigated. The values of the stability constants of the complex $[Np(NO_3^-)]^{3+}$ at ion strengths of 0.50, 1.00, 1.50, and 2.00 were equal to 2.80, 2.20, 2.30, and 2.00, respectively. The values of the stability constants of the complex $[NpCl]^{3+}$ for ion strengths of 0.50, 1.00, and 2.00 were equal to 1.40, 0.92, and 1.02, respectively. The thermodynamic stability constants of complexes of the type $[MnO_3]^{3+}$ were calculated for U^{4+}, Pu^{4+}, and Np^{4+}. (tr-auth)

10338 ISOPIESTIC METHOD OF PHYSICAL CHEMICAL ANALYSIS. II. THE QUESTION OF THE COMPLEX FORMATION IN THE SYSTEM $UO_2(NO_3)_2$–$MeNO_3$–H_2O. Vdovenko, V. M.; Ryazanov, M. A. Radiokhimiya, 8: 519-25(1966). (In Russian).

On the basis of previously developed matrices of the isopiestic diagram, the question of complex formation in aqueous solution of

uranyl nitrate and nitrates of the alkali metals was examined. It was found that in the system $UO_2(NO_3)_2-NaNO_3-H_2O$ in diluted solutions, complex formation between uranyl ions and nitrate ions does not proceed by the formation of uranyl dinitrate. In the systems $UO_2(NO_3)_2-MeNO_3-H_2)$ (Me = K^+, NH_4^+, Rb^+, and Cs^+), the complex formation of uranyl ions with nitrate ions proceeds down to the formation of trinitrateuranylate ions. The supposition was made that in the presence of the nitrates of potassium, ammonium, rubidium, and cesium, the complex formation is accompanied by the destruction of the hydrate film of interacting ions, whereas in the presence of sodium nitrate such destruction probably does not occur. (tr-auth)

10339 INVESTIGATION OF THE COMPLEX FORMATION OF AMERICIUM AND PROMETHIUM BY THE EXTRACTION METHOD. Stary, I. Radiokhimiya, 8: 504-9(1966). (In Russian).

The extraction constants of americium (log K = −7.48) and promethium (log K = −7.84) with 4,4,4-trifluoro-1-(2-thienyl)1, 3-butanedione in benzene solvent were determined. The composition and stability constants of americium and promethium complexes with tartaric acid (log β_1 = 3.9, log β_2 = 6.8 for Am and Pm), oxalic acid (log β_2 = 8.3, log β_3 = 11.8 for Am and Pm), nitrilotriacetic acid (log β_2 = 19.71 for Am log β_2 = 19.74 for Pm), ethylenedinitrilotetraacetic acid (log β_1 = 16.91 for Am log log β_1 = 16.94 for Pm), and 1,2-cyclohexylenedinitrilotetraacetic acid (log β_1 = 18.21 for Am and log β_1 = 18.17 for Pm) were determined. It was shown that americium complexes are closer to promethium complexes than to europium complexes with respect to stability. (tr-auth)

10340 INVESTIGATION OF THE FIXATION OF LONG-LIVED SPLINTER RADIOACTIVE ISOTOPES IN CALCINED CARBONATE ROCKS. Bernovskaya, R. N.; Gromov, V. V.; Zimakov, I. E.; Spitsyn, V. I. Radiokhimiya, 8: 585-90(1966). (In Russian).

The effects of calcination on the degree of fixation of ^{90}Sr, ^{106}Ru, ^{137}Cs, and ^{144}Ce in carbonate rocks was investigated. It was found that with increase of the calcination temperature, the transition of radioactive isotopes into the liquid phase (ground water) was decreased. The addition of SiO_2 promoted the irreversible fixation of splinter radioactive elements in the carbonates. The possibility of using carbonate rocks for the fixation of radioactive splinters was explored. (tr-auth)

10341 POLAROGRAPHY OF URANYL–NITRILOTRIACETATE COMPLEX. Lai, Tsai-teh; Chen, Jia-yong (Cheng Kung Univ., Tainan, Taiwan). Anal. Chim. Acta, 37: 253-9(Feb. 1967).

Polarographic studies of solutions of uranium(VI) and nitrilotriacetic acid were carried out in perchlorate medium at ionic strength 0.25. Reversible and diffusion-controlled reduction waves were obtained in the pH range of 1.5 to 4.1. Above pH 4.1, the irreversible waves became reversible in the presence of acetate buffer. Four kinds of chelate species, UO_2HX, UO_2X^-, $UO_2(OH)X^{2-}$, and $UO_2(Ac)X^{2-}$, were identified. The U(V)–NTA complex was unstable at high pH and completely dissociated at pH 6.30. The effects of pH and ligand concentration on the wave parameters are discussed in detail. (auth)

10342 CHEMILUMINESCENCE OF SOME REACTIONS IN CONCENTRATED SULFURIC ACID. Kazakov, V. P. (Inst. of Inorganic Chemistry, Academy of Sciences, USSR). Zh. Fiz. Khim., 39: 2936-41(1965). (In Russian).

The chemiluminescence was recorded with a type M12FS35 photomultiplier with a type EPPV-60 automatic recorder. The spectrum of the chemiluminescence was taken with a type UM-2 monochromator and the light was recorded with a type FEU-18 photomultiplier. Experimental results are shown in a series of curves. The following new chemiluminescent systems were found: reactions of the products of the electrolysis of sulfuric and phosphoric acids near the anode in the presence of salts of UO_2^{2+}, Ce(III), Tb(III), and quinine; and, the reaction of strong oxidizers, such as ozone, and sodium bismuthate with a solution of UO_2SO_4 in concentrated sulfuric acid. The reaction of the final products of the electrolysis of $H_2S_2O_8$, H_2O_2, and H_2SO_4 with a solution of UO_2SO_4 is not a source of chemiluminescence. Solution of $UO_4 \cdot 2H_2O$ in acid does not produce light. A mechanism consisting of the recombination of SO_4^- ion radicals with the participation of UO_2^{2+}, Tb^{3+}, and Ce^{3+} complexes, in sulfuric acid is proposed. (JPRS)

10343 DISSOLUTION OF METALS BY AC ELECTROLYSIS. Box, W. D. (Oak Ridge National Lab., Tenn.). Nucl. Appl., 2: 299-303(Aug. 1966). (ORNL-P-1578).

A method was developed for dissolving noble metals and metals resistant to HCl. This method employs the use of either half-wave or full-wave alternating current electrolysis in HCl. The effects of the following variables on the rate of solution were investigated: acid concentration, current density, current wave form, current frequency, agitation of solution, and addition of fluoride ion. The rates of solution for cadmium, copper, gold, indium, iridium, palladium, platinum, rhodium, tantalum, and tungsten were studied. (auth)

10344 URANIUM CHLORINATION IN FUSED SALTS. Olander, D. R. (Univ. of California, Berkeley). A.I.Ch.E. (Amer. Inst. Chem. Eng.) J., 13: 191-2(Jan. 1967). (UCRL-17080).

Previously reported results were used as a basis for an analysis of the kinetics of the chlorination of uranium tetrachloride in a fused LiCl–KCl eutectic by a model based upon diffusion of U(IV) in a falling liquid film with a chemical equilibrium restriction at the interface. Discrepancies in theoretical and experimental results are noted. (J.G.B.)

10345 TETRABROMOPLATINATE(II). ACID HYDROLYSIS AND ISOTOPIC EXCHANGE OF LIGANDS WITH BROMIDE ION. Teggins, John E.; Gano, David R.; Tucker, Mary Ann; Martin, Don S. Jr. (Ames Lab., Ames, Iowa). Inorg. Chem., 6: 69-75 (Jan. 1967).

The equilibrium constant for the acid hydrolysis of $[PtBr_4]^{2-}$ was measured at 15, 25, and 40°C. Spectrophotometric evidence indicated the presence of $[Pt_2Br_6]^{2-}$ in the solution. Isotopic exchange rates between the bromide ligands and free bromide were measured over extensive concentration ranges at the indicated temperatures by the use of ^{82}Br. The exchange rate is characterized satisfactorily by the expression $R_{ex} = k_1[PtBr_4^{2-}] + k_2[PtBr_3(H_2O)^-] + k_3[PtBr_4^{2-}][PtBr_3(H_2O)^-]$. The value of $k_1 = 2.2 \times 10^{-4}$ sec^{-1} at 25°C describes the aquation reaction for $[PtBr_4]^{2-}$. A value of $k_2 = 2.2 \times 10^{-4}$ sec^{-1} for the aquation of $[PtBr_3(H_2O)]^-$ was determined only approximately. The value of $k_3 = 0.22$ sec^{-1} M^{-1} characterizes the formation of a dimer transition state. Evidence was provided that this intermediate was not $[Pt_2Br_6]^{2-}$. There was no evidence for a direct nucleophilic replacement of a bromide ligand by bromide ion. (auth)

10346 CRYSTAL STRUCTURE OF PROTACTINIUM PENTACHLORIDE. Dodge, Richard P.; Smith, Gordon S.; Johnson, Quintin; Elson, Robert E. (Univ. of California, Livermore). Acta Crystallogr., 22: 85-9(1967). (UCRL-14581).

$PaCl_5$ forms monoclinic crystals with lattice constants a = 7.97, b = 11.35, c = 8.36 Å; β = 106.4°. The probable space group is C2/c, and the unit cell contains four $PaCl_5$ units. The structure consists of infinite chains of non-regular pentagonal bipyramidal $PaCl_7$ groups which share pentagon edges. $PaCl_5$ therefore provides an example of the comparatively rare coordination number of seven, and illustrates a way of achieving an overall stoichiometry of 1:5. Pa–Cl bond distances fall into two classes: (a) 2.43 (twice) and 2.46 Å to non-bridging Cl, and (b) 2.70 (twice) and 2.76 Å (twice) to bridging Cl. The Cl–Pa–Cl bond angle along the axis of the pentagon is 176 ± 1°. (auth)

10347 PRECIPITATION AND HYDROLYSIS OF THORIUM(IV) IN AQUEOUS SOLUTION. III. THE COMPOSITION OF THE PRECIPITATES IN THE SYSTEM THORIUM NITRATE–POTASSIUM PHTHALATE. Bilinski, H. (Inst. Ruder Boskovic, Zagreb). Croat. Chem. Acta, 38: 71-81(1966).

Precipitation from water solutions of thorium nitrate and potassium phthalate was investigated for a broad range of concentrations of both precipitation components. The influence of pH and time on the formation of various precipitates was studied, the composition and characteristics of the precipitates being determined by chemical analysis, and ir and NMR spectra. The following precipitates were characterized: $Th(OH)_4$ without water of crystallization; Th (Phthalate)$_2$ without water of crystallization; and thorium hydroxide-phthalate polymer with unknown formula. An empirical formula was derived, which shows the conditions for precipitation of thorium hydroxide in the presence of potassium phthalate. In the soluble mixed hydroxophthalato thorium complex, two OH^- ions are bound per one thorium. (auth)

10348 SYNTHESIS OF POTENTIAL RADIOPROTECTIVE COMPOUNDS. I. STUDIES ON THE REACTION BETWEEN 2-METHYLAZIRIDINE, 1-AMINO-3-CHLORO-2-PROPANOL, 3-AMINO-2-BROMO-1-PROPANOL AND THE PHOSPHOROTHIOATE ION INCLUDING STRUCTURAL INVESTIGATIONS OF THE COMPOUNDS FORMED. Akerfeldt, Stig (Research Inst. of National Defence, Sundbyberg, Sweden). Acta Chem. Scand., 20: 1783-9(1966).

2-Methylaziridine was found to react with the phosphorothioate ion in such a manner that the primary carbon–nitrogen bond was broken yielding S-(2-aminopropyl) phosphorothioate. It was found that 1-amino-3-chloro-2-propanol and 3-amino-2-bromo-1-

propanol are both easily cyclisized to 2-aminomethyl oxirane. This compound reacted with the phosphorothioate ion in such a manner that the primary carbon–oxygen bond was broken yielding S-(3-amino-2-hydroxypropyl) phosphorothioate. The isolated reaction products showed considerable radioprotective properties in mice. (auth)

10349 PROTOLYTIC CLEAVAGE OF VINYL ETHERS. GENERAL ACID CATALYSIS, STRUCTURAL EFFECTS AND DEUTERIUM SOLVENT ISOTOPE EFFECTS. Salomaa, Pentti; Kankaanperae, Alpo; Lajunen, Martti (Univ. of Turku, Finland). Acta Chem. Scand., 20: 1790-1801(1966).

The kinetics of the acid-catalyzed cleavage of the following vinyl ethers were studied in dilute hydrochloric acid solutions in water and in buffer mixtures of different composition: ethyl, 2-chloroethyl, isopropyl, butyl and isobutyl vinyl ethers, methyl isopropenyl ether, and 2,3-dihydropyran. Spectrophotometric and gas-chromatographic techniques were used. The reactions were found to exhibit general acid catalysis with a Brønsted α of approximately 0.5. A rate-determining proton transfer from the catalyst acid is proposed as being the likely reaction mechanism. The value of the gross isotope effect, k_D/k_H, which was 0.406 for the hydronium ion-catalyzed hydrolysis of 2-chloroethyl vinyl ether at 25°C, was in accord with the values reported for other reactions proceeding through a rate-determining protonation of ethylenic linkage. (J.G.B.)

10350 EFFECTIVE SITE ON ACID CATALYSTS REVEALED IN n-BUTENE ISOMERIZATION. Ozaki, Atsumu; Kimura, Kazuko (Tokyo Inst. of Tech.). J. Catalysis, 3: 395-405(Oct. 1964).

1-Butene isomerization was carried out at room temperatures with deuterated acid catalysts, such as silica–alumina, silica–magnesia, silica–zirconia, nickel oxide–silica, alumina, alumina–boria, and nickel sulfate-on-silica, as well as with nondeuterated catalysts in the presence of deuterated propylene or other hydrocarbons. Reaction mixtures were separated by gas chromatographic column and analyzed for deuterium distribution by mass spectrometry. The exchange behavior revealed in the experiments was remarkably dependent on the evacuation temperature of the deuterated catalysts. For evacuation temperatures near 100°C, most of the deuterated catalysts gave deuterated products; the deuterobutene concentrations found in product 2-butenes were much larger than in unreacted 1-butene. However, the larger deuterobutene concentrations in 2-butenes decreased with a rise in the evacuation temperature of the deuterated catalysts, down to negligible concentration for evacuation at 500°C, whereas the conversions of reactant increased with increases in evacuation temperature above 100°C. On the other hand, with most of the nondeuterated catalysts evacuated at 500°C, 1-butene isomerization in the presence of deuteropropylene revealed an essentially identical behavior of H-D exchange with that on the deuterated catalysts evacuated at 100°C. Evidently n-butene isomerization on these catalysts proceeds at least partly through a proton donor-acceptor mechanism with either Brønsted acids on the surface or the carbonium ions formed by adsorption of olefins on Lewis acid sites serving as proton donors, although in the case of alumina this mechanism is questionable. (BBB)

10351 CATALYTIC REACTIONS OF ANISOLE AND DEUTERIUM ON METAL FILMS. Anderson, R. B. (McMaster Univ., Hamilton, Ont.); Kemball, C. J. Catalysis, 6: 82-91 (Aug. 1966).

Reactions between anisole and D were followed over films of Ni, Pt, or Pd using a mass spectrometer to determine the products. No exchange occurred in the methoxy group except at high temperatures over Ni. The side group appeared to have little directing influence on ring exchange except on Ni where the H atoms in the ortho positions were replaced more slowly than the other ring H's. There were similarities between the reactions of anisole and the behavior of alkylbenzenes on the metal films. Thus, exchange was faster than the deuteration to form cyclohexyl methyl ether over Ni, but both reactions occurred at comparable rates on Pt and Pd. Some hydrogenolysis involving the rupture of the phenyl-oxygen bond occurred on Pt and the slow deuteration on Ni was also accompanied by hydrogenolysis of anisole. (BBB)

10352 AMERICYL(V) AND AMERICYL(VI) CHLORO-COMPLEXES. Bagnall, K. W.; Laidler, J. B.; Stewart, M. A. A. (Atomic Energy Research Establishment, Harwell, Eng.). Chem. Commun., No. 1, 24-5(Jan. 11, 1967).

It is stated that when ethanol was added to a solution of Am(V) and CsCl in 1M HCl a pale green precipitate was obtained which was isostructural with the Np complex $Cs_3NpO_2Cl_4$. Repeated analysis of a number of samples prepared from solutions of widely differing CsCl concentrations, however, suggested that the Am compound was $Cs_8(AmO_2)_3Cl_{11}$. Treatment with concentrated HCl gave a dark red solid which was found to be the americyl(VI) chloro-complex $Cs_2AmO_2Cl_4$, existing in two crystal forms. Formation of the americyl(VI) compound was surprising, since the AmO_2^{2+} ion is a strong oxidising agent and reduction by chloride ion would be expected in acid media. Reduction of $Cs_2AmO_2Cl_4$ to Am(III) occurred rapidly on dissolution in 11M HCl, whereas slow reduction to Am(V) occurred in 0.5M acid. Formation of the americyl(VI) salt does not appear to be the result of disproportionation. It may be that oxidation occurs because the lattice stabilization energy of the americyl(VI) chloro-complex is higher than that of the americyl(V) compound. Some experimental details are given. (UK)

10353 OXIDATION OF UO_2 CONTAINING SMALL ADDITIONS OF OTHER OXIDES. Landspersky, H.; Voboril, M. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). J. Inorg. Nucl. Chem., 29: 250-2(Jan. 1967).

The oxidation of UO_2 in air at elevated temperatures was reviewed. Literature data indicate that additions of other oxides do not effectively stabilize the UO_2 against oxidation. Additives of the oxides of Mg, Ca, Al, Ti, Mo, and V were introduced into UO_2 by co-precipitation, and thermogravimetry and differential thermal analysis were used for studying the physicochemical characteristics of the products. Activation energies for the oxidation of pure UO_2 were calculated and results compared with those for UO_2 with additives. (UK)

10354 THE REACTIVITY OF CO-ORDINATED ACETYLACETONE. PART I. ^{18}O EXCHANGE AND AQUATION OF TRISACETYLACETONATOCHROMIUM(III). Aggett, J.; Odell, A. L. (Univ. of Auckland, N. Z.). J. Chem. Soc. (London), A, No. 12, 1820-2(1966).

Trisacetylacetonatochromium (III) undergoes acid-catalyzed aquation to form a bisacetylacetonato-derivative, the rate of aquation showing linear dependence on the Hammett acidity function H_0. Oxygen-18 exchange between solvent water and free acetylacetone proceeds rapidly in H-perchloric acid, but exchange with acetylacetone co-ordinated to chromium(III) is slow compared with aquation in solutions of the same acidity. It is inferred that "one-ended dissociation" as found in trisoxalato-complexes does not occur. (auth)

10355 ELECTRON DIFFRACTION STUDY OF THE OXIDATION OF UO_2 AND THE STRUCTURE OF A U_3O_{8-x} SUPERSTRUCTURE PHASE. Steeb, S.; Mitsch, P. (Max-Planck-Institut fuer Metallforschung, Stuttgart). J. Inorg. Nucl. Chem., 29: 45-50 (Jan. 1967). (In German).

Thin films of UO_2, which were either fine-crystalline or mono-crystalline, were treated in an electron diffraction set with oxygen (10^{-3} torr) between 300 and 750°C for about 20 hr. Diffraction photographs were taken in transmission from time to time. The fine-crystalline specimens showed transformation to UO_{2+x} and U_3O_{8-x}. Other phases, such as U_3O_7 or U_3O_8, could not be observed. The hexagonal U_3O_{8-x}-phase exhibited a super structure cell with a = 6.72 Å, c = 6 × 4.105 Å. The lattice constant of UO_{2+x} decreased with increasing time of oxidation, but increased at the moment when the U_3O_{8-x}-superstructure phase was formed. This shows that part of the oxygen for the formation of U_3O_{8-x} must be taken from UO_{2+x}. At a pressure of 10^{-4} torr the mono-crystalline specimens form a superstructure with $a = 3a_{UO_{2+x}}$; at 10^{-3} torr a tetragonal superstructure with $a = 4a_{UO_{2+x}}$, $c = a_{UO_{2+x}}$ was formed. The latter phase has the composition $UO_{2.19}$. It probably forms the oxygen-rich phase border of UO_{2+x}. The atomic arrangements during the oxidation of UO_2 to U_3O_8 can be described in a similar way as with the systems Nb–O and Ta–O; initially additional oxygen atoms are built into the lattice in a disordered manner. At distinct concentrations they arrange in long periods, forming superstructure cells. This also is in accordance with the formation of superstructures during reduction of U_3O_8. (auth)

10356 DIPOLE MOMENT AND MICROWAVE SPECTRUM OF BROMO-ACTETYLENE. Jones, H.; Owen, N. L.; Sheridan, J. (Univ. Coll. of North Wales, Bangor). Nature, 213: 175(Jan. 14, 1967).

It is stated that the microwave rotation spectrum was easy to observe and indicated that the dipole moment of the molecule is not more than 0.01 D. The J = 2 → 3 and 3 → 4 transitions were measured for $^{79}BrCCH$ and $^{81}BrCCH$ and the J = 2 → 3 transitions for $^{79}BrCCD$ and $^{81}BrCCD$. High electrostatic fields were required for the production of resolvable Stark effects in the lines of the molecular ground states. The nuclear quadrupole fine structures showed second order perturbations, and were analyzed to give spectroscopic constants. Spectra due to molecules excited in the bending modes ω_4 and ω_5 were also easily observed and distinguished by their much stronger Stark effects. Bond lengths were calculated. The strength of the spectra indicates that work in progress on species containing ^{13}C in natural concentration should lead to a more accurate and complete set of bond lengths. (UK)

10357 KINETIC ISOTOPIC EXCHANGE STUDIES OF METAL ION SUBSTITUTION IN EDTA CHELATES. I. Co(II)–COBALT (II)–EDTA EXCHANGE. Krishnan, S. S.; Jervis, R. E. (Univ. of Toronto). J. Inorg. Nucl. Chem., 29: 87-95(Jan. 1967).

The rate of isotopic exchange of cobalt (II) ion with cobalt (II)–EDTA complex is measurable (reaction half time of approximately 20 to 100 min) in a pH range of 4.8 to 6.1 and concentrations of Co(II) ion and complex of the order of 10^{-3} to 10^{-4} M. Under these conditions the exchange rate was first order in the complex concentration and varied in a complicated manner, being of partial order in the concentration of cobalt (II) and hydrogen ion. The experimental rates of exchange are expressed within experimental precision by: $[R/(\text{mole/l per sec})] = k_1[Co^{2+}][CoEDTA^{2-}] + k_2[H^+][CoEDTA^{2-}] + k_3[Co^{2+}][CoEDTA^{2-}][H^+]$ where $k_1 = 0.070$ l/mole per sec; $k_2 = 11.6$ l/mole per sec; and, $k_3 = 1.00 \times 10^4$ l^2/mole^2 per sec; at a temperature of 20°C. Arrhenius activation energies corresponding to k_1, k_2, and k_3 evaluated from measurements at 20, 30, and 40°C were found to be, 16.0, 12.1, and 10.6 kcal/mole, respectively. The entropy of activation corresponding to k_1 was −12 eu. The substitution reaction mechanism suggested by the results appeared to involve the unprotonated chelate, $Co(II)EDTA^{2-}$ as well as the species $Co(II)HEDTA^-$. The observation that the cobalt (II)–EDTA complexes are not as labile as other transition element chelates is qualitatively in agreement with the predictions of crystal field calculations made on the assumption of a S_F1 dissociative mechanism involving octahedral complexes and weak field metal–EDTA interaction. (auth)

10358 KINETIC ISOTOPIC EXCHANGE STUDIES OF METAL ION SUBSTITUTION IN EDTA CHELATES. II. ZINC(II)–ZINC–EDTA EXCHANGE. Jervis, R. E.; Krishnan, S. S. (Univ. of Toronto). J. Inorg. Nucl. Chem., 29: 97-103(Jan. 1967).

Using the method of radioisotopic exchange, the substitution of zinc(II) ion in zinc–EDTA complex was observed to occur at a measurable rate over a concentration range of 10^{-5} to 10^{-6} M in both species and within the pH range of 6 to 7 at room temperature. Because of erratic behaviour of ^{65}Zn ion at very low tracer concentrations (~10^{-12}M), suggestive of radiocolloid formation, exchange experiments were done using freshly prepared ^{65}Zn-labelled chelate. The substitution rate of zinc(II) ion in zinc–EDTA at 20°C in 0.05 M acetate buffer was summarized within experimental error by: $R = k_1[Zn^{2+}][ZnEDTA^{2-}] + k_2[ZnEDTA^{2-}][H^+] + k_3[ZnEDTA^{2-}][H^+]^2 + k_4[ZnEDTA^{2-}]$ where R is the substitution rate in units of mole/l per sec and the specific rate constants have the following values at 20, 30, and 40°C: $k_1 = 4.13$, 26, and 96 l/mole per sec; $k_2 = 76$, 178, and 256 l/mole per sec; $k_3 = (1.3, 0.68, \text{and } 1.5) \times 10^8$ l^2/mole^2 per sec; and $k_4 = (7.7, 15, 17) \times 10^{-5}$ sec^{-1}, respectively. Activation energies corresponding to these values are 29, 12, 1.6, and 7.7 kcal/mole, respectively. The zinc–EDTA chelate was quite labile and substitution of zinc(II) ion through the spontaneous decomposition of chelate was an appreciable contribution to the overall reaction rate in all experiments. The reaction mechanism postulated indicated several parallel paths involving the unprotonated zinc–EDTA chelate and also the protonated species $ZnHEDTA^-$ and ZnH_2EDTA^0, suggesting that acid-catalysed decomposition of the chelate facilitated the disruption of metal-chelate bonds in the transition state. Comparison of these results with similar studies of other transition element EDTA chelates indicates that zinc(II) chelate undergoes substitution more rapidly than the d^7 and d^8 cobalt and nickel chelates. This finding is qualitatively in agreement with crystal field predictions assuming octahedral configuration and a weak field metal–EDTA interaction. (auth)

10359 PREPARATION AND PROPERTIES OF THE URANATES OF CALCIUM AND STRONTIUM. Cordfunke, E. H. P.; Loopstra, B. O. (Reactor Centrum Nederland, Petten). J. Inorg. Nucl. Chem., 29: 51-7(Jan. 1967).

Preparation of the uranates of calcium and strontium by solid state reactions is described. A number of new compounds have been found of which thermal stability, heats of formation, and x-ray powder data are given. (auth)

10360 METHYL CYANIDE AND NN-DIMETHYLACETAMIDE COMPLEXES OF THORIUM AND URANIUM TETRAHALIDES, URANYL CHLORIDE, AND URANYL BROMIDE. Bagnall, K. W.; Brown, D.; Jones, P. J. (Atomic Energy Research Establishment, Harwell, Eng.). J. Chem. Soc. (London), A, No. 12, 1763-6(1966).

The tetrachloride and tetrabromide of thorium and of uranium were reacted at room temperature with anhydrous methyl cyanide to form the complexes $MX_4 \cdot 4CH_3CN$ (M = Th and U; X = Cl and Br). The tetrabromide complexes reacted with NN-dimethylacetamide (DMA) to form the compounds $MBr_4 \cdot 4DMA$. Methyl cyanide and DMA complexes of uranyl chloride and uranyl bromide, $UO_2Cl_2 \cdot CH_3CN$ and $UO_2X_2 \cdot 2DMA$ (X = Cl and Br) were also prepared. Some chemical properties, infrared spectra, and magnetic susceptibilities are reported for these complexes. (auth)

10361 FREE ENERGIES OF TRANSFER OF ALKALI CHLORIDES FROM LIGHT TO HEAVY WATER FROM CELLS WITHOUT LIQUID JUNCTION POTENTIALS. Salomaa, Pentti; Aalto, Veli (Univ. of Turku, Finland). Acta Chem. Scand., 20: 2035-42(1966).

Electrochemical measurements have been made on the cells M (in Hg)/MCl (in D_2O)/AgCl, Ag–Ag, AgCl/MCl (in H_2O)/M (in Hg), in which M is Li, Na, or K. From the emf values obtained free energy changes were calculated for the transfer processes: MCl (in H_2O) → MCl (in D_2O). The dilute solution values for the different chlorides were found to be virtually the same, viz. +210 ± 10 cal/mole at 25°C, referred to standard states in the molarity units, which for these solutions gave the same values as those in the mole fraction or reduced molality units (i.e., moles of solute per 55.5 moles of water). The similarity of the emf values suggests that most of the transfer free energies are to be ascribed to the chloride ions. The results are discussed in terms of the structural differences between liquid H_2O and D_2O. Making use of other recent electrochemical and thermodynamic data the experimental values are also applied to derive the equilibrium constant for the isotopic fractionation of hydrogen between water and the aqueous hydronium ion at different temperatures. At 25°C, e.g., a value of 9.0 ± 0.3 is calculated for the equilibrium constant L of the reaction: $2D_3O^+ + 3H_2O = 2H_3O^+ + 3D_2O$. (auth)

10362 HYDROGEN SORPTION BY THIN NIOBIUM FILMS. della Porta, P.; Giorgi, T. (SAES Getters SpA, Milan). Vacuum, 16: 379-82(1966).

Sorption of hydrogen by thin Nb films, evaporated at 10^{-9} torr, was studied at low pressures and at temperatures of 77 and 293°K. Measurements were carried out employing a Bayard-Alpert gage and an omegatron-type mass spectrometer, both supplied with lanthanum hexaboride-coated filaments. For very thin films (<0.1 mg/cm^2) the sorption capacity was independent of temperature and directly proportional to the evaporated Nb. Measured capacity corresponded to an atomic ratio H : Nb of about 1 : 2. The initial sorption rate seemed to be independent of the film thickness. The shape of the curve relating sorption rate to quantity sorbed was different at the 2 different temperatures. The absence of a definite relation between the quantity of H gettered and the temperature of the film indicated that the process is not one of simple solution of the gas within the metal. Results with Nb are compared to those obtained with Ti films. At 298°K the capacity of a Nb film is about a quarter that of a Ti film of equal weight, while at 77°K a Nb film has a capacity for H which is about 10 times greater than a Ti film of the same weight at the same temperature. (BBB)

10363 PROGRESS IN THE SCIENCE AND TECHNOLOGY OF THE RARE EARTHS. VOLUME 2. Eyring, Leroy (ed.). New York, Pergamon Press, 1966. 369p. $15.00.

The second annual survey of progress in the technology of rare earths is presented. The subjects treated include: exchange coupling, preparation, thermodynamic and magnetic properties of rare earth chalcogenides and pnictides, rare earth halides, physical properties of mixed cation oxides, use and applications, rare earth complexes, structural and solid-state chemistry, and author and subject indexes. (P.C.S.)

10364 COMPARISON OF DEUTERIUM AND TRITIUM ISOTOPE EFFECTS. Robinson, John Keith. Houston, Tex., Rice Univ., 1966. 41p.

Thesis.

Primary kinetic tritium isotope effects, k_H/k_T, were obtained for three reactions. These are the oxidation of phenyl trifluoromethyl carbinol by basic aqueous permanganate, the ionization of 2-nitropropane in 60% t-butyl alcohol catalyzed by collidine, and the oxidation of leuco crystal violet by chloranil in acetonitrile. The isotope effect was measured directly in the alcohol oxidation. In the other reactions the rate constant for the reaction of the appropriate tritiated compound, k_T, was measured. The tritium isotope effects obtained were compared to those calculated using previously measured deuterium isotope effects. The observed and calculated values were expected to agree only when proton tunneling does not make an important contribution to the rate constants. In cases where tunneling is important, the calculated value was expected to exceed the observed one. In the alcohol oxidation, the value of k_H/k_T predicted from calculations is 55 and the measured k_H/k_T is 57.1 ± 2.4. This would seem to indicate that no important non-classical proton behavior is taking place in this reaction. The calculated k_H/k_T for the ionization of the nitro compound is 82.9. The observed k_H/k_T is 155 ± 6. This large deviation in an unexpected direction could be due to the fact that iodine was used in the rate measurements of the protium and deuterium substituted compounds but was absent in the system involving the tritiated

compound. Further investigation is necessary to verify not only the three rate constants involved but also the similarity of the processes measured. In the oxidation of the leuco dye, the calculated k_H/k_T is 27.3. Incomplete measurement of the tritium isotope effect indicates that the value is 19.0 ± 1.9. This deviation in observed and predicted values of k_H/k_T confirms other evidence that hydrogen tunneling is important in this system. (Diss. Abstr.)

10365 METHOD FOR DISSOLVING ZIRCONIUM AND FORMING STABILIZED ALKALINE SOLUTIONS THEREOF. Gens, T. A. (to U. S. Atomic Energy Commission). U. S. Patent 3,298,957. Jan. 17, 1967.

A method for forming a stable alkaline solution of Zr comprises dissolving Zr in an aqueous solution of NH_4F and a Zr-complexing agent selected from the group consisting of tartaric acid, glycolic acid, lactic acid, and salts of these acids, which are soluble in aqueous NH_4F solutions, and then adjusting the resulting solution to an alkaline pH at which the resulting zirconium complex remains in solution. (AEC)

10366 ISOTOPE EFFECT STUDY OF MECHANISMS OF THE CURTIUS, HOFMANN, AND LOSSEN REARRANGEMENTS. Wright, Joe Carrol. Fayetteville, Ark., Univ. of Arkansas, 1966. 71p.

Thesis.

A comparative carbon and nitrogen isotope effect study of the Curtius, Hofmann, and Lossen rearrangements was made utilizing the successive labeling technique. Specific emphasis was placed on the relative timing of bond rupture and group migration in each rearrangement. The Curtius rearrangement was studied using benzazide in isopropyl alcohol at 82°C. The Hofmann rearrangement was run with N-bromobenzamide in a solution of sodium methoxide and methyl alcohol at 50°C. The Lossen rearrangement was conducted with potassium benzoylbenzohydroxamate in methyl alcohol at 50°C. The isotope effects for the reactions were calculated using the fraction of reaction, isotopic analysis of the product at that fraction of reaction, and isotopic analysis of the product at complete reaction, and results are presented schematically. Results are consistent with the predictions for the concerted mechanism in each rearrangement, but not for the reactive intermediate mechanism. This was particularly evident in that an isotope effect was found for the phenyl-1-^{14}C-labeled compound in each rearrangement. This indicates that rearrangement takes place in the transition state of the rate-determining step for all three rearrangements. This leads to the conclusion that no azene intermediate is involved in any of the three reactions and that they all rearrange by a concerted mechanism. (Dissertation Abstr.)

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Refer also to abstracts 10315 and 11328.

10367 (AECL-2644) COMPOSITION AND PHYSICAL PROPERTIES OF ORGANIC COOLANTS. A Summary of Canadian Data and Use. Hatcher, S. R.; Tomlinson, M. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). May 1966. 24p. Dep. mn. AECL $1.00.

Physical property data are summarized for organic coolant mixtures formed from the terphenyl feed mixture, Santowax OM, and from the hydrogenated terphenyl feed mixture HB-40. Particular attention was given to the coolant mixtures of stationary composition, including about 30% High Boiler decomposition products, formed by prolonged use under reactor conditions. Properties depended to some extent on the manner of operation of the system. (auth)

10368 (AGN-8178) FISSIOCHEMICAL DEVELOPMENT PROGRAM. Semiannual Progress Report, July 1-December 31, 1965. Hamling, B. H.; Kahn, S.; Miller, R. I.; Osterholtz, F. D.; Ward, J. A.; Whipple, J. C. (Aerojet-General Nucleonics, San Ramon, Calif.). Feb. 1966. Contract AT(04-3)-596. 146p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Investigations concerned with use of fission fragment energy to bring about chemical reactions of interest are described. A newly developed and more accurate range-energy equation was used to calculate ranges of ^{235}U and ^{252}Cf fragments in all elements. Results are presented in the form of a periodic chart. The equation is strictly applicable to metals only; calculated results for gaseous absorbers are less reliable. Studies of tungsten-UO_2 fibers were initiated. Nickel-UO_2 fibers used in capsule irradiations were found to crumble to powder; the weakness is ascribed to nickel oxide grain growth. Results of fissiochemical irradiation of nitrogen-methane mixtures, pure CO_2, and CO_2 with NO_2 and CH_4 additions are presented. Analysis of fissiochemically produced HCN indicates that essentially all of the ^{14}C produced in the loop is incorporated in the product. In studies of reaction mechanisms, various effects of radical-radical reactions were observed. N-atom yield was measured in systems where charge transfer is possible. Calculations for a typical N_2-CH_4 mixture indicate G(N) > 3.7 and G(charge transfer from N_2^+) ≈ 2.3. High pressure mass spectrometry of CH_4-N_2 and CD_4-N_2 mixtures showed no significant proton transfer to nitrogen. A solid product resulting from fission fragment irradiation of N_2-CO mixtures is under study and its nature has been deduced to some degree. G(N) for this product is about 1.7 and significantly increases when a small concentration of hydrogen is added to the gas. Similar solids have been produced by high energy electron irradiation and by microwave discharge. (auth)

10369 (AGN-8196(Vol.1)) FISSIOCHEMICAL DEVELOPMENT PROGRAM. Final Report. Cusack, John H.; King, Paul A. (Aerojet-General Nucleonics, San Ramon, Calif.). Aug. 1966. Contract AT(04-3)-596. 296p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments concerned with the use of fission fragment energy to bring about chemical reactions of interest are summarized. While the depth and breadth of the understanding of fission fragment physical behavior, track effects, chemical reactions amenable to fissiochemical induction, etc., were significantly extended, no single fuel/product combination can yet be shown to have strong economic potential using current industrial forecasting techniques. Typical of the accomplishments during the program are: differential absorber experiments using silicon surface barrier detectors were combined with theory, empiricism, and sophisticated computer approaches, to allow the derivation of general fission fragment range-energy equations and the determination of energy deposition efficiencies for a diversity of solid fuel compositions and shapes. A new family of proprietary ceramic and metallic fibrous fuels were developed and evaluated; the most promising of the compounds with the solid solution, ZrO_2-UO_2, although its radiation and physical stability must be improved before it is fully qualified for reactor use. A number of related basic radiation chemistry investigations were conducted. Most involved nitrogen or ethylene; pressure and track effects were particularly stressed. Based on the ^{60}Co, e^-, and fission fragment radiolysis of ethylene, it was found that electronically excited reactions are only slightly affected by pressure or LET and that increasing LET increases radical-radical reactions and decreases ionic reactions. The use of scavengers to react with radiolytically produced free radicals or ions in a fission track seems destined to be inefficient. A gas-phase fissiochemical loop has been operated in the Union Carbide 5 MW reactor for the past 3 years. Most operations involved the N_2-CH_4 system; HCN yield varied directly with temperature and flow and inversely with pressure and CH_4 concentration. Maximum G(HCN) was about 3 molecule/100 eV at 400°C. Moderate to severe solid product formation was experienced. All ^{14}C formed from ^{14}N(n,p)^{14}C was incorporated in the product as H^{14}CN. Preliminary process design and analysis indicated the fissiochemical production of HCN to be economically marginal at best. Loop irradiation of CO_2 and CO_2-CH_4 mixtures indicated G(CO) as high as 10, representing a radiation-to-chemical-energy conversion of about 29%. Although the conclusions emerging from a comprehensive experimental survey of potentially economic fissiochemical reactions were not highly encouraging, an unexpected reaction between CO and N_2 was discovered. The resulting solid product could be induced by ^{60}Co, mixed reactor (n,γ), and high frequency microwave discharge radiation as well as by fission fragments. Maximum G(N) was about 3 and maximum nitrogen incorporation more than 30% w. (auth)

10370 (AGN-8196(Vol.2)) FISSIOCHEMICAL DEVELOPMENT PROGRAM. Final Report. Cusack, John H.; King, Paul A. (Aerojet-General Nucleonics, San Ramon, Calif.). Aug. 1966. Contract AT(04-3)-596. 264p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Results are reported for studies on: fissiochemical nitrogen fixation; fission fragment radiolysis of carbon dioxide; selection, technology, and irradiation of new chemical systems; and process design and application analysis. In a Factorial Block Experiment (FBX) on fissiochemical nitrogen fixation, G(HCN) increased with increasing temperature and decreased with decreasing flow (increasing dose), increasing pressure (decreasing dose rate), and high CH_4 concentrations. Addition of water vapor, helium, or mixed CH_4 radiolysis products had little effect on G(HCN) or G(CH_3CN), while addition of NH_3 decreased yield. An analytical scheme was developed for measuring the ^{14}C activity in trap-collected quantities of fissiochemically produced HCN. In the presence of NO_2, G(CO) ranged as high as 12 in the fission fragment radiolysis of CO_2. The addition of up to 15% CH_4 did not significantly alter CO yield. From a mechanistic point of view, the fission fragment irradiation of CO_2 is apparently a track ef-

fect involving the polymerization of CO_2 ions followed by neutralization, producing more than one molecule of CO per ion. Analysis techniques were developed to permit quantitative measurements of hundreds of specific products in radiolysis systems. Preliminary analyses of an HCN production are described. (P.C.H.)

10371 (EUR–3168.f) SYNTHESE DE PRODUITS DE REFERENCE APPARENTES AUX POLYPHENYLES. RAPPORT FINAL. (Synthesis of Polyphenyl-Related Reference Products. Final Report). Beaudet, C.; Marcq, A.; Rygaert, J. (Societa d'Etudes, de Recherches et d'Applications pour l'Industrie, Brussels (Belgium)). Nov. 1966. 37p. (In French). Dep. mn.

Hydrogenated biphenyls were synthesized for use as reference compounds for the identification of radiolysis products obtained from benzene and biphenyl. Reactions leading to the formation of the three pure phenylcyclohexenes are reported. The Grignard reaction of phenyl magnesium bromide with cyclohexanone followed by the dehydration of the intermediate 1-phenylcyclohexanol yielded phenyl-1-cyclohexene and the reaction of phenyl magnesium bromide with 2-bromocyclohexene gave phenyl-3-cyclohexene. Pure phenyl-4-cyclohexene was prepared by ring closure of styrene with butadiene. The thermal decomposition of the methylxanthates of phenyl-2-cyclohexanol and phenyl-4-cyclohexanol gave only mixtures of phenylcyclohexene isomers. Attempts to synthesize pure isomers of the phenylcyclohexadiene series are reported. Both the thermal decomposition of phenyl-1-cyclohexenol-3, the dehydrobromination of phenyldibromocyclohexanes, and the partial hydrogenation of diphenyl led to the formation of isomeric mixtures of phenylcyclohexadienes. The ultraviolet and infrared spectra of phenyl-1-, phenyl-3-, and phenyl-4-cyclohexene are described. (auth)

10372 (INR–758/XVII/C) METODY IMPULSOWE W CHEMII. (Pulse Methods in Chemistry). Zagorski, Zbigniew P. (Institute of Nuclear Research, Warsaw (Poland)). Oct. 1966. 20p. (In Polish). Dep.

Pulse methods in chemistry are presented and discussed in the order of increased range of chemical changes in the system. The review begins with relaxation methods (e.g., temperature jump method) in which only the chemical equilibrium is shifted suddenly. The survey ends with pulse radiolysis methods, where in very short periods of time intermediates are formed, reacting afterwards into stable compounds. (auth)

10373 (MIT–334-70) EFFECT OF REACTOR IRRADIATION ON SANTOWAX WR: 1. RADIOLYSIS REACTION ORDER AND FAST NEUTRON EFFECT. 2. RADIOPYROLYSIS. Mason, E. A.; Timmins, T. H.; Morgan, D. T.; Bley, W. N. (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering). Oct. 1966. Contract AT(38-1)-334. 322p. CFSTI $3.00 cy, $0.65 mn.

Santowax WR was irradiated in the M.I.T. In-Pile Loop Facility at 300 and 427°C. The irradiations were made in a stainless steel irradiation capsule installed in an unfueled sample assembly lined with cadmium in Fuel Position 20 of the MITR. The fast neutron fraction of the dose rate was 0.07 ± 0.01. Both steady-state and transient terphenyl concentration conditions were employed in the irradiations. Steady-state operating conditions were maintained by periodically removing coolant samples from the loop and distilling them to remove the high boilers (HB). The terphenyls and low and intermediate boilers (LIB) were returned to the circulating coolant in the loop along with fresh makeup coolant. The fast neutron and gamma dose rates were measured with adiabatic calorimeters and foil monitors. The MITR thermal power was raised from about 2 MW to about 5 MW during these irradiations. The average dose rate to the coolant was approximately 0.0066 W/g at 2 MW and approximately 0.016 W/g at 5 MW. The maximum dose rate to the coolant was 0.15 W/g and 0.38 W/g at 2 MW and 5 MW, respectively. Three low temperature irradiations were made at different steady-state concentration levels in order to determine the apparent reaction order for radiolysis. The results indicated an apparent reaction order of radiolysis of 1.7 with respect to total terphenyl concentration. Using this reaction order, the low temperature irradiation data of M.I.T. and other laboratories were correlated well by a fast neutron effect ratio, G_N/G_γ, of 3.9 ± 0.4 for meta-rich terphenyl mixtures at 320°C. Ortho terphenyl was found to be less stable to gamma rays than meta terphenyl at this temperature. Above 350°C, irradiated coolant was found to have higher first-order thermal decomposition (radiopyrolysis) rate constants than unirradiated coolant. The radiopyrolysis rate constants were calculated in the range 360 to 450°C, and were compared with post-irradiation pyrolysis measurements of M.I.T. and other laboratories. The maximum uncertainty on these values appeared to be ±75% at 360°C, ±40% at 400°C, and ±15% at 450°C. Procedures for estimating coolant makeup rates in organic-cooled reactors are presented and discussed. Physical property measurements included density, viscosity, melting point, and number average molecular weight. Heat transfer measurements showed that standard correlations could be used to determine the heat transfer rate using the bulk physical properties of irradiated coolant. The best correlation for all these data was $Nu = 0.023\ (Re)^{0.8}(Pr)^{0.4} \pm 10\%$. No evidence of scale buildup or fouling of heat transfer surfaces was observed. (auth)

10374 (NP–16442) MECANISME DE LA RADIOLYSE DES ALCENES. (Mechanism of the Radiolysis of Alkenes). Etienne Berumen, Guillermo C. (Grenoble Univ. (France). Faculte des Sciences). Nov. 21, 1966. 70p. (In French). Dep. mn.

Thesis.

The radioinduced oligomerization of 1-octene at 50 and 250°C, 1-diisobutylene and 2-diisobutylene at 50, 100, 150, and 240°C in the nuclear reactor "Siloé" and with a Van de Graaff accelerator was studied. The dimer fraction of the 1-octene was separated in its different isomers, and the structure elucidated using gas chromatography and nuclear magnetic techniques. The following compounds were identified: trans-8-(or 7)-hexadecene, 9-methyl-6-pentadecene, and 2-hexyl-1-decene. The obtained oligomers are compared with those produced in a thermal, anionic, ionic, and free radical polymerization. The vinylic double bond found in the oligomer and the scavenger effect of I_2 suggests that a free radical mechanism is operative for the radioinduced oligomerization of terminal olefins at 50 and 250°C. A structure with both arrangements is proposed; head to head 51.4% at 250°C and 46.4% at 50°C, head to tail 48.6% at 250°C and 53.6% at 50°C with only one double bond per molecule, the most are trans vinylene and then vinylidine and less than 12%, vinyl. (auth)

10375 (NYO–1715-16) SOLID STATE POLYMERIZATION INITIATED BY IONIZING RADIATION. Final Report, June 1, 1954–August 1, 1966. Morawetz, Herbert (Polytechnic Inst. of Brooklyn, N. Y. Inst. of Polymer Research). Contract AT (30-1)-1715. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Studies on solid state gamma radioinduced polymerization of such compounds as acrylamide, calcium and sodium acrylates, butadiene-1-carboxylic acid, methacrylic acid, p-benzamidostyrene, and vinyl stearate are discussed. A particularly fruitful line of study resulted from the observation that acrylamide forms solid solutions with propionamide. The presence of the saturated analog had surprisingly little effect on the polymerization velocity, but it reduced, even at quite low concentration, the chain-length of the polymer obtained. (P.C.H.)

10376 (NYO–2499-20) EFFECTS OF MERCAPTANS AND DISULFIDES ON PHOTOCHEMICAL AND HIGH ENERGY RADIATION INDUCED REACTIONS. Progress Report, November 1, 1965–November 1, 1966. Cohen, Saul G. (Brandeis Univ., Waltham, Mass. Dept. of Chemistry). Contract AT(30-1)-2499. 19p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The proposed mechanism of inhibition of photochemical and radioinduced reactions by mercaptans involves rapid transfer of hydrogen atom from mercaptan to an intermediate radical and from an intermediate radical to thiyl radical. In the benzophenone–2-propanol system the intermediate radicals, $(C_6H_5)_2\dot{C}OH$ (I) and $(CH_3)_2\dot{C}OH$ (II) are reconverted to the starting materials, benzophenone and 2-propanol, respectively, inhibition resulting. This mechanism would require that if the radicals I and II were formed from benzhydrol and acetone they would still be converted by the sulfur compounds to benzophenone and 2-propanol. Inhibition would not result but the system would be transformed. This has been demonstrated confirming the mechanism of action of sulfur compounds. Additional experiments have been carried out on the photoreduction of aminobenzophenones in acidic aqueous 2-propanol. Photoreduction at 313 mμ of p-dimethylaminobenzophenone in 1:1 2-propanol–water, 6N in HCl, led to the pinacol with quantum yield ≅ 0.3. Photoreduction of 4-benzoylphenyltrimethylammonium chloride at 313 mμ in 1 : 1 2-propanol–water led to the pinacol with quantum yield = 0.64. Other water soluble ketones, such as 4-benzoylbenzoic and benzophenone are also being studied. Photoreduction of the sodium salt of 4-benzoylbenzoic acid studied in 1:1 2-propanol as a function of pH. Preliminary results indicated that a tertiary amine is an excellent photoreducing agent for 4-benzoylbenzoic acid in aqueous medium, although the tertiary amine is not very effective in photoreduction of benzophenone in benzene. Sodium 4-benzoylbenzenesulfonate was synthesized. It is photo-reduced in aqueous 2-propanol, quantum yield ≅1.1. The photoreduction is quenched by naphthalene, less effectively by 1-naphthyltrimethylammonium tosylate, and still less effectively by 2-naphthylsulfonic acid. The photoreduction of p-aminobenzophenone by diisopropylamine showed quantum yield ≅ 0.02 and led to the pinacol. The photoreduction of p-aminobenzophenone by triethylamine was remarkably effective, quantum yield = 0.45 at 10^{-3}M ketone. The reaction was unusual, being less effective at higher concentration of ketone and more effective at high intensity of light. (P.C.H.)

10377 (SGAE-CH-39/1966) STRAHLUNGSAUSGEHAERTETE HOLZ-KUNSTSTOFF-KOMBINATIONEN (HKK). (Radiation-Tempered Wood-Plastic Combinations (HKK)). Guetlbauer, F.; Proksch, E.; Bildstein, H.; Slais, E. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Institut fuer Chemie). 1966. 41p. (In German). Dep. mn.

By impregnation of wood with various vinyl polymers and concurrent hardening with energetic radiation, products were obtained that combine the properties of the initial components advantageously. They preserve the esthetic appearance of wood but show much higher resistance properties as well as increased water stability. The preparation methods, properties, cost, and application possibilities were described. (tr-auth)

10378 RADIATION-INDUCED DECOMPOSITION OF ION-EXCHANGE RESINS. PART II. THE MECHANISM OF THE DEAMINATION OF ANION-EXCHANGE RESINS. Ahmed, M. T.; Clay, P. G.; Hall, G. R. (Imperial Coll. of Science and Tech., London). J. Chem. Soc. (London), B, No. 12, 1155-7(1966).

Trimethylamine is a major product of the γ radiolysis of De-Acidite FF, a polystyrene-based, quaternary ammonium anion-exchange resin. In the irradiated dry resin $G(Me_3N) = 4.0$ to 4.4 and in the slurried state (resin:water = 1:2, w/w) $G(Me_3N) = 3.2$. When the samples were slurried with solutions of electron scavengers (N_2O, H^+, NO_3^-) decreased values of $G(Me_3N)$ were obtained. The results suggest that the slurried resin is deaminated both by direct radiolysis and by the reaction of hydrated electrons produced by the radiolysis of the slurrying water. (auth)

10379 INVESTIGATION OF EFFECT OF NEUTRON IRRADIATION ON STRUCTURE AND PROPERTIES OF LaB_6. Kovalchenko, M. S.; Ogorodnikov, V. V.; Krainii, A. G. At. Energ. (USSR), 21: 470-6(Dec. 1966). (In Russian).

Studies were made of the effects of neutron irradiation (10^{18} and 10^{20} neutrons/cm^2) on lanthanum hexaboride. Data were obtained on the radioresistance, changes in lattice parameter, microhardness, microbrittleness, and color of LaB_6. The influence of annealing on the reduction properties of specimens was also investigated. A new phase of a mixture of lanthanum hexaboride and lithium with microhardness of Gn/m^2 was found in irradiated and annealed specimens. (tr-auth)

10380 POLARITY EFFECTS IN THE RADIOLYSIS OF n-ALCOHOLS. Basson, R. A.; van der Linde, H. J. (Atomic Energy Board, Pretoria). J. Chem. Soc. (London), A, No. 1, 28-32 (1967).

The yields of solvated electrons and hydrogen atoms, the precursors of molecular hydrogen, have been determined for a number of irradiated alcohols. The ratio of these yields has been related to the ratio of the number of sub-excitation electrons which escape their parent ions to the number which undergo geminate recombination. It has been shown that both the yield of solvated electrons and the ratio of this yield to the yield of hydrogen atoms increase as the dielectric constant of the liquid increases. The half lives of solvated electrons in the alcohols have been calculated and shown to decrease with decreasing dielectric constant. (auth)

10381 LUMINESCENCE OF SOME MOLECULAR GASES FROM EXCITATION BY FAST ELECTRONS. II. Anton, Horst (Justus Liebig Univ., Giessen, Ger.). Ann. Phys. (7), 18: 178-93 (1966). (In German).

Additional studies on the luminescence of molecular gases, (N_2, CO_2, O_2, air, and N_2-O_2 mixtures) following excitation with 50-keV electrons are reported. From spectroscopic observations and decay time measurements conclusions can be drawn on the most significant excitation and quenching mechanisms of the luminescence. (tr-auth)

10382 RADIATION CHEMISTRY OF 6m-SULFURIC ACID. Dainton, F. S.; Gibbs, A. R.; Smithies, D. (Nottingham Univ., Eng.). J. Chem. Soc. (London), A, No. 1, 33-6(1967).

Yields of products formed by x irradiation of 6M H_2SO_4 containing Fe(II) or Ce(IV) + T(I) in the presence and absence of oxygen have been measured. These yields have been interpreted in terms of reactions involving oxidation or reduction by species derived from both water and sulfuric acid. (auth)

10383 RADICAL YIELD OF PROPIONALDEHYDE IN THE RADIOLYSIS OF n-PROPANOL. Basson, R. A.; Van der Linde, H. J. (Atomic Energy Board, Pretoria). Chem. Commun., No. 2, 91-2(1967).

It was suggested earlier by the authors that in the radiolysis of n-propanol the aldehyde is formed by more than one process and that both radical and molecular yields occur. This suggestion was based on the effect of scavengers on the hydrogen yield and considerations on the mechanism of the formation of molecular hydrogen. At that stage there was no definite experimental evidence of radical and molecular yields. Strong evidence has now been obtained, however, in favour of a two-part yield in a study of the effect of ferric chloride on the aldehyde production. The experimental studies are briefly described. It appears that the hydroxypropyl radicals involved may disproportionate as well as dimerise. (UK)

10384 ROLE OF O^- IN THE GAS PHASE RADIOLYSIS OF ALKANE–NITROUS OXIDE MIXTURES. Warman, J. M. (Mellon Inst., Pittsburgh). Nature, 213: 381-2(Jan. 28, 1967). (RRL-2310-189).

When an alkane gas is irradiated in the presence of N_2O, nitrogen is formed. This results from the dissociative capture of electrons by the N_2O. Thus $e + N_2O \rightarrow N_2 + O^-$. At constant dose rate $G(N_2)$ obeys the expected expression for competition between electron capture and ion recombination. $G(N_2)_\infty$, representing the nitrogen yield when all electrons are captured, is a constant for a given hydrocarbon. $G(N_2)_\infty$ is greater than the yield of electrons, G_e, calculated from the W value, and this was ascribed to subsequent reaction of O^- with N_2O. Mass spectrometric evidence was found for the following reactions: $O^- + N_2O \rightarrow N_2 + O_2^-$ and $O^- + N_2O \rightarrow NO + NO^-$. Mass spectrometric studies also showed that the predominant negative ion formed in oxygen-containing CO_2 is CO_3^-. CO_2 is not known to react with the radical or ionic species produced in alkane radiolysis. It was therefore thought that the addition of CO_2 to alkane–nitrous oxide mixtures might provide unambiguous evidence for the second reaction by competing with N_2O for O^-, thereby decreasing $G(N_2)_\infty$, which in fact was the case. It was also found that addition of small amounts of acetone to the alkane–nitrous oxide systems increased $G(N_2)_\infty$, in the limit, to 2 G_e. This can be explained by a competitive reaction of O^- with acetone to produce a species that subsequently reacts with N_2O quantitatively to form N_2. It is possible that the anomalously high yields of N_2 observed with solutions of nitrous oxide in high pH water and liquid alkanes also result from the subsequent reaction of O^- with N_2O. (UK)

10385 POLAROGRAPHIC INVESTIGATION OF THE RADIATION STABILITY OF LUMINESCENT MATERIALS, USED IN SCINTILLATING MATERIALS. Shimanskaya, N. L.; Nagornaya, L. L.; Dmitrieva, V. N.; Bezuglyi, V. D. Radiokhimiya, 8: 597-603(1966). (In Russian).

By means of the polarographic method of control of the percentage of luminescent materials in scintillating systems, it was shown that the radiation damage of the scintillation system is determined by the changes occurring not only in the solvent molecules but also in the luminescent molecules. The degree of radiation damage of luminescent materials of the R_1-X-R_2 types essentially depends on the nature of the basic X cycle. With the same substitutes R_1 and R_2 the ethylene derivatives appear the most stable and the Δ^2-pyrazolidine derivatives seem the least stable. The radiation stability of the luminescent materials depends to a substantial degree on the medium in which irradiation takes place. (tr-auth)

10386 REACTION OF TRITIUM RECOIL ATOMS ON THE SURFACE OF SOLIDS. Tsetskhladze, T. V.; Barnov, V. A.; Cherkezishvili, L. I. Radiokhimiya, 8: 591-7(1966). (In Russian).

During the realization of reactions of hot tritium atoms with ethane on the surface of different solids (silica gel, γ-Al_2O_3, molecular sieves) an increase of the specific activity of the irradiated gas and the comparative yields of the hot interaction products ethane and hydrogen was observed. On the molecular sieve NaA, the diameter of the pores of which agrees with the critical diameter of the molecules of the target, the probability of introduction reactions and the formation of labeled hydrocarbon compounds significantly increased in comparison with hydrogen breaking away reactions. (tr-auth)

10387 CHROMATOGRAPHIC METHOD FOR THE PREPARATION OF CARRIER-FREE RADIOIODINE PREPARATIONS WITH HIGH SPECIFIC (VOLUME) ACTIVITY. Zaitseva, N. G.; Kim, Khon-sil; Khalkin, V. A. Radiokhimiya, 8: 576-84(1966). (In Russian).

The previously unknown capacity of microquantities of iodine to be reversibly absorbed in the form of the chloride complex $ICl_2^- \cdot Cl_2$ on monofunctional sulfate cations of the type KU-2 and Dowex-50 from chlorine-saturated solutions of HCl and LiCl was found. The distribution coefficient is ~300 in 5 to 8M HCl(Cl_2) and ~1000 in 9 to 11M LiCl(Cl_2). On the basis of this result, a chromatographic method for the precipitation of carrier-free neutron-deficient iodine isotopes from lanthanum oxide irradiated with high-energy protons was developed. The preparations of radioiodine obtained were used for the preparation of high-grade sources, necessary for the investigation of the electron conversion spectrum. For this purpose, solutions containing iodine were dried on silver supports or the iodine was electrolytically precipitated on platinum cathodes from HCl–H_2SO_4 solutions. It was established

that the chromatographic method can be used for the separation of radioactive iodine isotopes from tellurium irradiated with thermal neutrons and from antimony irradiated with α particles. Preparations of iodine isotopes with a radioactivity of 1 to 2 c/ml is possible. The radiochemical purity of the preparations is more than 99.9%; the percentage of HCl is 2 to 3%. (tr-auth)

10388 PRODUCTION OF CARRIER-FREE ^{18}F. Kozyreva-Aleksandrova, L. S.; Levin, V. I.; Ivanov, Yu. F.; Zalesskii, V. G. Radiokhimiya, 8: 571-6(1966). (In Russian).

The sorption and desorption of carrier-free ^{18}F on column with hydrated zirconium oxide was investigated. $^{18}F^-$ fluoride was almost completely sorbed from neutral solutions on columns. The effects of the alkaline solution concentration on the speed of elution of the fluoride was established. An increase in solution concentration led to an increase in the elution speed. A method for the precipitation of ^{18}F from neutron-irradiated lithium carbonate, based on the sorption of the fluoride $^{18}F^-$ from neutral or weakly acid solutions on zirconium oxide hydrate columns with its subsequent elution with caustic soda, is proposed. ^{18}F with yields of ~80% was prepared. The concentration of ^{18}F in the preparations was not less than 99% and contained no more than 0.7% tritium and 0.2% ^{24}Na (within 5 hrs after the end of the irradiation). (tr-auth)

10389 POST-OXIDATION ON RADIOLYSIS OF ALCOHOLIC FERROUS SULFATE SOLUTION. Hung, Tsu-chang; Wai, Nganshou. Bull. Inst. Chem., Acad. Sinica, No. 12, 1-12(Sept. 1966).

The radioinduced oxidation of ferrous sulfate-acid solutions with the addition of small amounts of ethanol was studied. In air-saturated solution, a high G-value of ferric ion up to 70 molecules per 100 eV was observed. In the deaerated solution, $G(Fe^{3+})$ was only about 36.6 ± 3.4 molecules per 100 eV. The yield of acetaldehyde was found to be dependent of the added concentration of ethanol. And $G(H_2O_2)$ was only 1.3 molecules per 100 eV in the irradiation of 0.1M ethanol in 2.5×10^{-4}M $FeSO_4$ – 0.4M H_2SO_4 solution with the dose of 8.20×10^{17} eV/g. The post-oxidation effect of background radiation was also found to be prevalent. The oxidation of ferrous to ferric ion was measured spectrophotometrically. (J.G.B.)

10390 SEARCH FOR RADIATION DEAMINATIONS IN DNA. Lemmon, Richard M. (Univ. of Helsinki). Nature, 212: 1481-2 (Dec. 24, 1966). (UCRL-16842).

A search was made for deamination induced by radiation in water solutions of intact DNA labeled with ^{14}C. The samples were hydrolyzed and then exposed to a ^{60}Co gamma source at 1, 2, and 3×10^6 RAD (delivered for 10 to 30 hr). After irradiation the samples were subjected to hydrolysis again and also to chromatography. No detectable radioactivity was found in 5′-deoxyuridylic acid, which was added as carrier. It was concluded that it is probable that nucleic acid deaminations do not play the part in radiation genetics that was suggested by earlier observations of the radiation deamination of free bases. (P.C.H.)

10391 THE EFFECTS OF NEUTRON IRRADIATION ON METHANOL OXIDATION CATALYSTS. Gevaert, L. H.; Jervis, R. E. (Univ. of Toronto). J. Catalysis, 6: 200-8(Oct. 1966).

Oxidation of methanol to formaldehyde was studied over a temperature range from 209 to 270°C in a differential flow gas-phase reactor using catalysts irradiated with neutron doses up to 10^{20} neutrons/cm^2. Attempts were made to correlate the altered catalytic activity to defects produced by radiation damage and to a quantity of foreign atoms introduced throughout the catalyst by nuclear transmutations. The catalysts investigated were pure V_2O_5, V_2O_5 mixed with 1% chromium oxide, and a mixed tungsten oxide–molybdenum oxide. The gaseous reactant stream consisted of 20% oxygen, 0.75 to 6% methanol, and the remainder, nitrogen. The doped V_2O_5 (1% chromium) catalyst was found to be 30 to 50% more active than pure V_2O_5 with or without irradiation. The tungsten-molybdenum mixed oxide catalyst was 25% more active for methanol oxidation after irradiation and was 6 to 10% more active even after high-temperature annealing. By calculation from nuclear constants it was determined that 0 to 0.03% chromium and 0 to 0.06% rhenium were introduced by nuclear transmutation in the V_2O_5 and tungsten–molybdenum oxide catalysts, respectively. No significant differences in reaction mechanism or energy of activation were observed between the unirradiated and irradiated catalysts. (BBB)

10392 DETERMINATION OF HYPERFINE INTERACTION FIELDS IN NEUTRON IRRADIATED COBALT BY NUCLEAR ORIENTATION TECHNIQUES. Cracknell, Margaret F.; Wilson, G. V. H. (Oxford Univ.). Proc. Roy. Soc. (London), Ser. A, 296: 71-81(Jan. 10, 1967).

The hyperfine interaction field on ^{60}Co nuclei formed by thermal neutron irradiation of a single crystal of hexagonal cobalt at 4°K was determined from measurements of the anisotropy of γ radiation emitted when the sample was cooled to about 0.012°K. These measurements were repeated after the sample had been annealed successively at 20, 77, and 300°K. A reduction of (6 ± 4) % in the hyperfine field on the ^{60}Co nuclei was observed after annealing out the radiation damage. This result is discussed in terms of the positions in the lattice which might be occupied by a cobalt atom after the recoil caused by the γ-decay of the 8 MeV excited state of a ^{60}Co nucleus immediately after its formation. (auth)

10393 ON A METHOD FOR THE PRODUCTION OF CARRIER-FREE ^{18}F FROM NEUTRON IRRADIATED LITHIUM CARBONATE. Nikolov, K. (Sofia Univ.); Kolev, Z.; Mazhkarov, S.; Mutafchiev, K. Isotopenpraxis, 2: 433-5(Nov. 1966). (In Russian).

An effective regime for the irradiation of Li_2Co_3 with neutrons and a method for the production of carrier-free ^{18}F and the construction of a device for the distillation of $H^{18}F$ are described. This apparatus gives a choice of either operating with an open cycle in nitrogen gas as carrier of the $H^{18}F$ or in a closed cycle with a constant volume of the carrier gas. According to the choice of regime of irradiation of the target material, a solution of $Na^{18}F$ is obtained in the first case with a relative activity of about 350 to 400 μCi/ml, (the total volume of the solution being 30 ml), and in the second case of 2.5 to 3 mCi/ml (the total volume of the solution being 5 ml). In view of decreasing losses in activity the adsorption of $Na^{18}F$ on surfaces of glass, polyethylene, plexiglass, vinedur, and paraffin was studied, and also the dependence of adsorption on glass, vinedur, and paraffin on the pH of the solution. It was shown that the adsorption is largest on glass surface and smallest on surface of paraffin, and is negligible at values of pH > 7. (auth)

10394 ESR OF IRRADIATED o-TOLUIDINE HYDROBROMIDE. Krishnamurthy, M. V. (Tata Inst. of Fundamental Research, Bombay). Curr. Sci. (India), 36: 39-40(Jan. 20, 1967).

Electron spin resonance (ESR) absorption studies were made of gamma-irradiated o-toluidine hydrobromide. Examination of the spectra in different orientations suggested the presence of a free radical with the unpaired electron localized mostly on the nitrogen atom. ESR measurements were made along different orientations in ab, ac, and bc planes at 10° intervals. The two splitting constants obtained were 45 ± 1.5 and 14.5 ± 1 gauss. The larger splitting was assigned to the amino-protons from intensity considerations and from a study of partially deuterated sample. The proton splitting was nearly isotropic indicating that the amino group was undergoing rapid rotation at room temperature. The g-values and hyperfine coupling constants for the radical are tabulated. Study of irradiated p-toluidine hydrochloride crystals showed that the spectra obtained were essentially the same as the spectra of the o-toluidine hydrobromide. This suggests that the gamma damage was confined mainly at the nitrogen site. (D.H.M.)

10395 AN ATTEMPT AT RADIATION GRAFTING OF MALEIC ANHYDRIDE ON POLYETHYLENE. Zurakowska-Orszagh, Janina; Gabara, Wlodzimierz (Univ. of Warsaw). Nukleonika, 11: 669-71(1966).

Attempts made to graft maleic anhydride on polyethylene by gamma radiation in acetone or benzene solutions showed comparatively low numerical values for direct grafting. Post-effect grafting took place readily at 120°C. The most probable mechanism is cross linking, which explains the insolubility and infusibility of the grafted foil that was observed. (P.C.H.)

10396 EFFECT OF CROSSLINKS ON THE RECOMBINATION OF RADICALS IN ELASTOMERS. Kvashenko, Yu. Yu.; Kuzminskii, A. S.; Fedoseeva, T. S. Vysokomol. Soedin., 8: 2150-4 (Dec. 1966). (In Russian).

Radical decay in γ-irradiated sulfur vulcanates based on natural rubber was studied. In a wide temperature range sulfur bridges intensify the process and the radical decay rate is higher in polysulfide vulcanizates than in monosulfide ones. In glassified polymer, sulfur is supposed to facilitate intra- and intermolecular migration of free valency. (auth)

10397 INVESTIGATIONS ON RADIATION-CHEMICAL AMMONIA SYNTHESIS IN NUCLEAR REACTORS. Schrader, Richard; Schoenherr, Siegfried (Institut fuer Anorganische und Analytische Chemie der Bergakademie, Freiberg i. B.). Z. Anorg. Allg. Chem., 348: 168-74(Dec. 1966). (In German).

The formation of ammonia under the influence of mixed-reactor radiation and γ radiation was investigated using different nitrogen–hydrogen mixtures at approximately normal pressure and temperature without catalysts. The highest ammonia yield of 2.6% was obtained for 5.15×10^9 RAD of mixed radiation, equivalent to $G(NH_3) = 0.16 \pm 0.03$. It was concluded from the dependence of ammonia yield upon the gas composition and kind of radiation that the course of reaction is different for mixed-reactor and γ radiation. (auth)

10398 MASS-SPECTROMETRIC IDENTIFICATION OF TIN-ORGANO RADIOLYTIC PRODUCTS. Heldt, E.; Hoeppner, K.;

Krebs, K. H. (Humboldt-Univ., Berlin. Institut fuer Angewandte Isotopenforschung, Berlin). Z. Anorg. Allg. Chem., 348: 113-16 (Dec. 1966). (In German).

Products in radiolysis of dimethyldiethyltin were separated gas-chromatographically, then investigated by mass spectrometry. A comparison of the monoisotopic mass spectra with the spectra of the compounds of the sequence $(CH_3)_aSn(C_2H_5)_{4-a}$ shows that the most predominant products in radiolysis of dimethyldiethyltin are tetramethyltin, trimethylethyltin, and triethylmethyltin. (auth)

10399 IRRADIATED WOOD PLASTIC MATERIALS TECHNOLOGY. Harmison, Lowell T. Energ. Nucl. (Paris), 8: 307-9(July-Aug. 1966).

The development and testing of plastic-wood composite materials, the kinds of wood, the monomers, the impregnation processes, the radiation sources that can be used, and the nature of the products obtained are discussed. Their fields of application and the commercial market open to them are considered. (auth)

10400 EFFECT OF γ RADIATION ON POLYESTERS OF ADIPIC ACID AND DIETHYLENE GLYCOL. Apukhtina, N. P.; Zaitsev, N. B.; Rappoport, L. Ya.; Kozlova, N. V. Plast. Massy, No. 8, 60-2(1966). (In Russian).

In a study of the effect of γ radiation on saturated aliphatic polyesters (which are used as the main component in urethane polymers), polydiethylene adipates (PDEA) of molecular weight (MW) ~2000 and 4000 of the structure

$$H-[-OCH_2CH_2OCH_2CH_2O\overset{\overset{O}{\|}}{C}-CH_2CH_2CH_2CH_2\overset{\overset{O}{\|}}{C}-]_n-OCH_2CH_2OCH_2CH_2OH$$

were irradiated with radiation from ^{60}Co. The amount of absorbed energy was determined by ferrous sulfate dosimetry. A study of the dependence of the relative viscosity of benzene solutions of the polyesters on the dose absorbed showed a predominant role of cross-linking of PDEA during the irradiation, this effect being more pronounced as MW increases. Infrared spectroscopic data indicated that the polyester chains break down at the ester group, forming CO and CO_2; this was associated with a decrease in the quantity of C=O bonds and the appearance of unsaturation in the chain as the dose increased. The cross-linking occurred at the methylene groups. The different positions of the ir bands of α and β methylene groups made it possible to evaluate the relative rates of disappearance of these two types of groups under the influence of γ radiation. The polyester with MW ~4000 irradiated with 200 Mrad converted into a rubberlike elastomer consisting of a mixture of cross-linking and degradation products. Hard, cross-linked polyurethanes were successfully obtained from the irradiated polyesters at equimolar ratios of polyester to 2,4-toluylene diisocyanate at moderate temperatures (60 to 70°C). The degree of cross-linking of polyurethanes as a function of the dose was determined from the glass transition temperature of the polymers. (ATD)

10401 RADIATION-INDUCED LIQUID STATE POLYMERIZATION OF SOME CYCLIC ETHERS. Penczek, St.; Wieteszka, J.; Kubisa, P. (Research Inst. of Plastics, Warsaw). Makromol. Chem., 97: 225-31(1966).

Attempts were made to use ionizing radiation to induce polymerization of 14 cyclic ethers. Cyclohexene α-oxide was polymerized in the liquid state under the influence of ^{60}Co γ radiation at room temperature. Several other oxiranes (including glycidyl ethers) and oxetanes were investigated under the same conditions, but only cyclohexene α-oxide gave fairly high yields and rates of polymerization at the dose rate used (2.21×10^5 R/hr). According to the ir spectra, the polymer did not contain carbonyl groups and had an identical spectra to that of the cationically polymerized product (BF_3 in CH_2Cl_2 solution at −78°C). Since cyclohexene α-oxide itself is very reactive toward cationic catalysts and rather stable in the presence of even strong bases, a cationic mechanism of radioinduced polymerization is likely. This mode of H-abstraction is discussed. α-Hydrogen abstraction in cyclohexene oxide under the action of tert-butyl peroxide predominates over β-abstraction. The next step should be the attack of the radical on the monomer molecule and the competing reaction of rearrangement giving the corresponding ketone. This radical should also participate in the initiation and/or chain termination reactions if a radical process is involved. However, no carbonyl groups are present in the formed polymer, confirming a nonradical mechanism of polymerization. (BBB)

10402 CHEMICAL EFFECTS OF NEUTRON CAPTURE IN TETRAMETHYL SILANE. Snediker, David Kirk. University Park, Pa., Pennsylvania State Univ., 1965. 100p.

Thesis.

The products and their yields resulting from the $^{30}Si(n,\gamma)^{31}Si$ process were investigated and a study of the influence of radical scavengers, γ-radiolysis, and state of aggregation on these yields was made. Tetramethylsilane, purified by vapor chromatography, was encapsulated in quartz ampules and irradiated as a liquid at the core face of a nuclear reactor. The ampule was then broken in the feed stream of a vapor chromatograph. The active products were detected by conducting the chromatograph exhaust past a Geiger–Müller tube. An activity versus time trace was obtained by accumulating the G–M pulses in a TMC-400 channel analyzer set in multiscaler mode to count 30 sec in each channel. The prompt reactions were distinguished from the delayed by irradiating in the presence of nitric oxide as a radical scavenger. The influence of γ radiolysis, which produced methyl and trimethylsilyl radicals in copious quantities, was studied by reducing the γ dose by a factor of two using a lead shield. Several irradiations were conducted in the gas phase in order to further clarify the role of caging. The principal products detected and their yields expressed as per cent of total organic yield for tetramethylsilane irradiated as a liquid are tabulated. From these data, those obtained from experiments conducted at an attenuated γ dose, experiments conducted in the presence of nitric oxide, and experiments conducted in the vapor phase it is possible to deduce three processes that individually or in combination yield the observed products. The first such process is the cage process, taking place immediately after the recoil event and involving interactions between the recoil atom and its own methyl groups or the hydrogen atoms of its nearest neighbors. Such reactions yield the so-called precursor species: $SiCH_3$, $Si(CH_3)_2$, $Si(CH_3)_3$, and $Si(CH_3)_4$. Another process involving the reaction of the primary recoil species with methyl radicals produced by γ radiolysis yields the precursor species. All of the monomethyl precursor appears to come from cage processes. About half of the di- and tri-methyl species originates in cage processes, while the other half comes about as the result of reactions involving lower primary recoil species and radiolysis methyl groups. Nearly all of the tetramethylsilane originates in the methyl radical process. Once formed the precursor species react in either prompt or delayed reactions with the hydrogen environment or with radiolysis radicals to yield the observed products. The two processes are differentiated experimentally by scavenging the delayed reactions with nitric oxide. All of the silane, methylsilane, and tetramethyldisilane yields come about in prompt reactions, the former in hydrogen abstraction reactions by energetic, uncaged recoil atoms, and the latter pair in hydrogen abstraction or silicon–hydrogen bond insertion reactions by the monomethyl precursor. About half of the dimethyl silane yield, and about one-third of the trimethyl silane yield come about in prompt processes involving the dimethyl and trimethyl precursor species. Approximately half of the tetramethyl silane yield comes about in prompt reactions involving the same two precursor species. All of the penta- and hexamethyldisilane yields result from delayed or diffusive reactions. This same type of process, which probably involves reaction with radiolysis-induced radicals, accounts for half of the dimethylsilane yield, two-thirds of the trimethylsilane yield and half of the tetramethylsilane yield. (Diss. Abstr.)

10403 POLYVINYL CHLORIDE GRAFT COPOLYMERS. Pinner, Solomon Harris. (to B. X. Plastics Ltd.). British Patent 1,050,781. Dec. 7, 1966. Filed Sept. 7, 1961.

A process for the manufacture of crosslinked graft copolymers comprises subjecting a graft copolymer from polyvinyl chloride or a vinyl chloride copolymer and one or more ethylenically unsaturated monomers to the action of a crosslinking agent; such as ionizing radiation, ultraviolet radiation in the presence of a sensitizer, a free-radical polymerization initiator, or an elastomer curing agent or a polyanhydride or polyamine capable of reacting with epoxy plasticizers for polyvinyl chloride, or a combination of any two of these to effect crosslinking. (B.L.M.)

10404 METHOD FOR MODIFYING POLYMERIC SUBSTANCES WITH HIGH ENERGY RADIATION. Priesing, Charles P.; Volk, Henry; Grabiel, Charles E. (to The Dow Chemical Co.). U. S. Patent 3,281,263. Oct. 25, 1966. Filed Mar. 17, 1961.

A method for improving the characteristics and properties of solid, shaped polymeric substrate articles consists of contacting the previously shaped articles with an aqueous solution consisting of a mixture of a monomeric material that is polymerizable in aqueous media under the influence of high-energy radiation and a polymer to improve the uniformity of graft polymerization of the monomeric material onto the shaped article. Excess aqueous solution is removed from the shaped article, and the still wet substrate is exposed to high-energy ionizing radiation until at least the surface of the substrate becomes modified with the monomeric material graft polymerized onto it. The method is applicable to shaped substrates of cellulose, protein material, cellulose ester, acrylonitrile polymer, polyamide, polyester, and polyolefin. (B.L.M.)

Radiochemistry

Refer also to abstract 10257.

10405 (ORNL–4023) ^{238}Pu PRODUCTION BY A CONTINUOUS PROCESS. Binford, F. T.; Hartman, W. A. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 50p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A method for the production of ^{238}Pu by continuous irradiation and chemical processing of ^{237}Np is described. Equations showing the interrelation of the various process variables (production rate, efficiency of ^{237}Np utilization, and product quality) are developed. It is shown that, in principle, ^{238}Pu can be produced in currently available neutron fluxes at reasonably high production rates with better than 90% efficiency of ^{237}Np utilization and very high product purity. (auth)

10406 THE SELF-ABSORPTION OF AUGER ELECTRONS AND X-RAYS IN ^{54}Mn SOURCES PREPARED BY DIFFERENT METHODS. Bambynek, W.; Reher, D. (EURATOM, Geel, Belg.). Int. J. Appl. Radiat. Isotop., 18: 19-24(Jan. 1967).

The self-absorption of the 5-keV Auger electrons of Cr emitted after ^{54}Mn decay has been determined for sources prepared by seven different methods and on four different support materials. The lowest self-absorption of the Auger electrons, i.e., approximately 2%, has been found in sources prepared by vacuum evaporation. Sources obtained by other methods such as electrodeposition, electrospraying, and simple evaporation of a drop, show about 15, 25, and 50% self-absorption, respectively. Furthermore the measured Auger electron intensities depend considerably on the roughness of the support material. A calculation using a simple model shows that in very thin sources the ratio of the self-absorption of the Auger electrons and the x rays is in a first approximation independent of the layer thickness of the source. This makes possible an estimate of the self-absorption of the x rays distinct from that of the Auger electrons; the value is found to be 0.1 to 4% depending on the method of source preparation used. (auth)

10407 EFFECT OF THE LIGAND FIELD ON THE SZILARD–CHALMERS RECOIL OF ^{60m}Co AND ^{60g}Co STUDIED ON 28 COMPLEXES OF Co(III). Lazzarini, E. (Politecnico, Milan). J. Inorg. Nucl. Chem., 29: 7-14(Jan. 1967).

The possibility of the different behavior in the Szilard–Chalmers effect of ^{60m}Co and ^{60g}Co, formed by (n,γ) reactions, was investigated and confirmed. It was found that the ratio of their retentions (percentage of radioactive atoms in the original chemical compound) varies with the chemical constitution of the target. As a result of a systematic investigation carried out on 28 cobalt (III) complexes, it was possible to correlate the value of the effect with the chemical constitution of the target, in terms of the ligand field splitting of the 3d-orbitals of cobalt and the ability of the ligands to form π-bonds; in other words, the effect is correlated with the density of s-electrons at the nucleus and this density depends on the kind of ligand field. (auth)

10408 SORPTION OF ^{16}N ON GRAPHITE. French, R. L. D. (United Kingdom Atomic Energy Authority, Windscale Works, Eng.). Nature, 212: 1457-8(Dec. 24, 1966).

A gamma spectrometric technique was used to follow the adsorption kinetics of ^{16}N on a graphited surface. Because of the short half-life of ^{16}N, all measurements had to be carried out using a continuous flow technique rather than the batch system normally used in adsorption experiments. The count rate for ^{16}N normally rose suddenly and then fell over a period of several hours towards the original base line. The observed decrease in count rate is explained by assuming that the rate of adsorption of ^{16}N depends directly on the number of vacant sites and that these sites decrease in number as adsorption proceeds. (P.C.H.)

10409 RADIOCHEMICAL STUDY OF THE ANODIC CORROSION OF RUTHENIUM. Llopis, J.; Gamboa, J. M.; Alfayate, J. M. (CSIC, Madrid). Electrochim. Acta, 12: 57-65(Jan. 1967).

The corrosion rate of ruthenium in HCl at high potentials was studied. Metal passivation occurs under these conditions and corrosion rates are very low. For this reason a radiochemical technique, giving high sensitivity, was adopted. The metal, in sheet form, was irradiated in the JEN-1 reactor for 1 week, to a total of 4,975 MWm. Irradiation of ruthenium produced ^{97}Ru, ^{103}Ru and ^{105}Ru, but radiochemical analysis showed that after 30 days only ^{103}Ru contributed significantly to the residual activity. Corrosion was determined by counting 0.5cc samples of the HCl electrolyte solution at measured time intervals, employing a scintillation spectrometer. Details of the experimental technique are given. Two series of experiments were carried out, employing 2N and 4N HCl solutions at 50°C. Results are discussed. It was found that the metal undergoes some anodic corrosion even at potentials of 950mV, previously considered to cause passivation. A comparison was made with the behavior of platinum, which passivates more completely. A scheme is proposed to explain the influence of Cl^- on the mechanism of anodic corrosion of metals of the platinum group. (UK)

10410 THE SYNTHESIS OF ETHYLENE-1,2-T OXIDE. Ehrenberg, Lars; Pring, Brian (Univ. of Stockholm). Acta Chem. Scand., 20: 2207-10(1966).

Ethylene-1,2-T oxide was synthesized on a vacuum line by the following means: (a) reaction of acetylene and hydrogen-T bromide (obtained from phosphorus pentabromide and water-T) in UV-light to form 1,2-dibromoethane-1,2-T; (b) debromination with Zn to ethylene-1,2-T; (c) reaction with N-bromosuccinimide to form 2-bromoethanol-1,2-T; (d) reaction with KOH to form ethylene-1,2-T oxide. The yield of steps (a) + (b) was ca 100%, that of (c) + (d) ca 60%. The product was stored in dibutyl ether from which it could be distilled before use. The radiation chemical stability of this solution is discussed. (auth)

Separation Processes

Refer also to abstracts 10405, 10595, and 12151.

10411 (AERE-R–4766) A VERSATILE PROGRAMMED FRACTION COLLECTOR. Loveridge, B. A.; Wilson, J. D.; Hallett, R. (Atomic Energy Research Establishment, Harwell (England)). Feb. 1965. Reprinted Dec. 1966. 24p. Dep. mn. BIS $0.80. HMSO 4s.

An electrical fraction collector for use with ion exchange columns is described, which will accept beakers up to 250 ml in any combination of sizes. The volume of eluate to be collected in each beaker is programmed in advance and controlled either by drop-counting or by elapsed time. The maximum instrumental resolution is nearly 0.2% of the total volume to be collected, but the precision of any one fraction is about twice this figure due to variations in drop volume with ambient temperature. Fractions of varying or constant volume may also be collected in test tubes. (auth)

10412 (BNWL–318) ION-EXCHANGE SEPARATION OF KILOCURIE QUANTITIES OF HIGH PURITY PROMETHIUM. Wheelwright, E. J.; Roberts, F. P.; Upson, U. L.; Kirby, L. J.; Myers, T. R.; Van Tuyl, H. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1966. Contract AT(45-1)-1830. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Optimum conditions for the purification of the individual light rare earth elements by ion exchange elution were determined for the eluting agents EDTA, HEDTA, and DTPA. The conditions apply directly to the isolation of macro-quantities of pure promethium from the fission product rare earths. DTPA was demonstrated to be superior to both EDTA and HEDTA. Operating conditions are described that allow a 4-fold reduction of both the elution time cycle and the volume of waste solution generated compared to previously reported work. Seven 9-ft-high, water-thermostated ion exchange columns, ranging from 8 to 1 in. ID, plus associated tanks, pumps, and instrumentation, were installed in one of Battelle-Northwest Laboratory's hot cells. The technology developed during the isolation of 1,000,000 Ci of ^{147}Pm in this equipment is summarized. (auth)

10413 (HW-SA–3527) HANFORD SALT CYCLE PROCESS. II. ENGINEERING DEVELOPMENT IN A HIGH LEVEL RADIOCHEMICAL FACILITY. Bond, W. R.; Jansen, G. Jr.; Mudge, L. K. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Aug. 17, 1964. Contract AT(45-1)-1350. 16p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The main steps in operating the Salt Cycle process in a High Level Radiochemical Facility are described and the process results which have been obtained to date are discussed. The areas where further work needs to be done to conduct the operations in an optimum fashion and to achieve separations which meet the requirements of an economically sound recycle flowsheet are pointed out. (auth)

10414 (INR–754/XIII/C) EKSTRAKCJA URANU(VI) Z ROZTWOROW KWASU SIARKOWEGO ROZTWORAMI TLENKU TROJ-N-OKTYLOFOSFINY W BENZENIE. (Uranium(VI) Extraction from Sulphuric Acid Solutions with Tri-N-Octylphosphine Oxide Solutions in Benzene). Deptula, Czeslaw (Institute of Nuclear Research, Warsaw (Poland)). Aug. 1966. 12p. (In Polish). Dep.

Uranium(VI) extraction from sulfuric acid solutions with tri-n-octylphosphine oxide solutions in benzene was investigated. On the basis of the dependence of log E_α^0 - log[TOPO] and the results of the chemical analysis of the organic phases, the composition of the extracted compound was determined ($UO_2SO_4 \cdot 2TOPO$). (auth)

10415 (ISO–522) TECHNICAL CRITERIA FOR THE PREVENTION OF CRITICALITY, CHEMICAL PROCESSING DIVISION. Tomlinson, R. E. (Isochem Inc., Richland, Wash.). Oct. 14, 1966. Contract AT(45-1)-1851. 8p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Technical criteria to be used in developing the limits within which chemical processing facilities are to be designed and operated are defined. The intent of these criteria is to maintain the risk of criticality at the lowest level that can be achieved at a cost that is considered reasonable relative to the risk involved. These criteria are based on the operating experience accumulated in 22 years of processing fissile materials. (P.C.H.)

10416 (K–1691) ORGDP FUEL REPROCESSING STUDIES SUMMARY PROGRESS REPORT, JANUARY THROUGH JUNE 1966. Smiley, S. H.; Pashley, J. H.; Schappel, R. B. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Jan. 18, 1967. Contract W-7405-eng-26. 60p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Studies of a group of processes aimed at purifying and recovering valuable uranium and plutonium from spent nuclear reactor fuels were made. Preparation of conceptual plant studies with concomitant definition of problem areas associated with the process and technology and plant design and component development, including scale-up and testing of crucial process equipment and auxiliaries were the two main phases of the studies. The topics covered include the status of current low-enrichment fuel flow sheet studies, including the systems analysis project; the composition of irradiated fuels; the fates of fission products during volatility process; the separation of mixtures of uranium hexafluoride–plutonium hexafluoride-fission product fluoride by distillation; preliminary considerations in the sizing of a reactor to produce bromine pentafluoride from bromine; sodium fluoride fluid-bed sorber criticality calculations; some theoretical aspects of cold trapping; corrosion testing and related studies, process and reactor studies, including semiworks pilot-plant operation, sampling, a fluid-bed level indicator, and pressure drop measurements; outlet gas filter studies; sorption–desorption systems for product purification, using batch sodium fluoride pellet traps; connector testing; status of valve selections; and evaluation of a peripheral compressor. (auth)

10417 (KFK–432) DIE EXTRAKTION DER ELEMENTE RADIUM, ACTINIUM, PROTACTINIUM, AMERICIUM, UND CURIUM MIT 8-HYDROXYCHINOLIN. (Extraction of Radium, Actinium, Protactinium, Americium, and Curium Elements with 8-Hydroxyquinoline). Mosdzelewski, Klaus (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). July 1966. 40p. (In German). Dep. mn.

The extraction behavior in the chelate formation of trace amounts of Ra^{2+}, Ac^{3+}, Am^{3+}, Cm^{3+}, and Pa^{5+} with 8-hydroxyquinoline (HOX) and its derivatives 5,7-dichloro-8-hydroxyquinoline (HDCO) and 5,7-dibrom-8-hydroxyquinoline (HDBO) were investigated. Ra^{2+} requires for its extraction high oxine and ligand anion concentrations. From the extraction curves it was determined that Ra^{2+} is extracted as $Ra(OX)_2 \cdot 4HOX$, however the formation of $Ra(OX)_2 \cdot 3HOX$ cannot be completely excluded. By addition of equal molar masses of n-butylamine to oxine, the extraction was improved with respect to that without addition to the oxine in weakly alkaline solution and worsened in strongly alkaline solutions. Ac^{3+} and Cm^{3+} were extracted with oxin from aqueous solution as $AcY(OX)_2$ and $CmY(OX)_2$ with $Y = OH^-$ probably, as was previously found for Am^{3+}. The extraction curve of Cm is identical with that of Am. The 50% extraction of Cm with 0.1 M HOX occurs at pH = 5.25 and that of Ac at pH = 6.62. The 50% extraction of Cm with 0.205 M HDBO occurs at pH = 5.09 and that of Am at pH = 5.05. The precipitation of Cm^{3+} with 0.04HDCO occurs at pH = 5.05. Because of the tendency of Pa^{5+} to hydrolyze, its extraction behavior with oxin and dibromooxine was investigated by reextraction. From the distribution curves for trace masses and microconcentrations 10^{-9} to 10^{-5} M Pa can be extracted as follows: Pa^{5+} forms with oxine a chelate of the average composition $H_2[Pa(OH)_{4.5}(OX)_{2.5}]$ and with dibromooxine $H_2[Pa(OH)_6(OX)]$ in addition to probable polymer species. The 50% extraction of Pa^{5+} with 0.1 M HOX occurs at pH = 1.35 and pH = 11.48 and with 10^{-3} M HDBO at pH = 11.6. (P.C.H.)

10418 (MLM–1354) LIMITATION ON INITIAL RADIAL DISPLACEMENT AND VELOCITY FOR A MASS FILTER SEPARATING ISOTOPES. Eppink, D. W. (Mound Lab., Miamisburg, Ohio). June 30, 1966. Contract AT(33-1)-Gen-53. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A theoretical discussion by W. Paul on the initial conditions and the maximum amplitude of oscillation of an ion in the field of a quadrupole mass filter is analyzed. The development given by Paul (Paul, W., et al., Z. Phys. 152, 143-182, (1958)) was verified but the ellipses in one of his figures were found to be incorrect. Correct plots of these ellipses are given and were verified by a study of ion trajectories calculated by two independent methods. The dependence of limitations in initial conditions on the position of the operating point in the mass filter stability diagram is demonstrated. (auth)

10419 (NYO–3503-2) SEPARATION OF IMPURITIES IN WATER BY FREEZING. A Progress Report. Geyer, John C.; Waller, Robert (Johns Hopkins Univ., Baltimore, Md. Dept. of Sanitary Engineering and Water Resources). Apr. 1965. Contract AT(30-1)-3503. 81p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A review of theoretical concepts derived from physical chemistry and metallurgy indicate that the boundary layer of enriched solution at the ice–solution interface is of vital importance in determining the efficiency of separation. Studies show that increasing rates of propeller agitation result, up to a point, in increased efficiency. A wiper agitator was devised which sweeps the surface of the ice and thus destroys the boundary layer. The wiper agitator surpasses the performance of the propeller stirrer even though the wiper operates at a much lower rotational speed. The cooling bath temperature was shown to have a large effect upon separation efficiency, mainly through smaller crystal sizes at lower temperatures. Studies made with varying concentrations of initial solutions reveal that the level of per cent conductivity retained in the ice remains at about 1% until solutions of over 5000 μmho are reached, after which the per cent retained climbs rapidly. It is thought that perhaps the temperature available to these higher strength solutions is not as low as the "local" equilibrium temperature. (auth)

10420 (ORNL-TM–1593) PLUTONIUM-RELATED SAFETY ASPECTS IN DESIGNING THE FLUIDIZED-BED VOLATILITY PILOT PLANT. Miles, F. W. (Oak Ridge National Lab., Tenn.). Nov. 1966. Contract W-7405-eng-26. 31p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Studies were made to provide needed design criteria for equipment to ensure safety in handling plutonium in the Fluidized-Bed Volatility Pilot Plant (FBVPP). This pilot plant will recover uranium and plutonium from UO_2 power reactor fuels. The quantity of plutonium to be handled per run will vary from about 200 to 1,250 g while the in-plant inventory may reach a limit of 10 kg. To accomplish this purpose, literature from a number of AEC installations was reviewed. The characteristics of plutonium pertinent to the FBVPP are tabulated. These characteristics include nuclear, physical, chemical, and biological properties. Radiation hazards relative to plutonium were investigated, and critical masses of pertinent plutonium compounds are listed. Containment philosophies and design criteria for equipment were established. Problem areas that require more detailed studies are: neutron and gamma shielding of the PuF_4 product; removal of accidentally released PuF_6 from ventilation air streams; and methods for avoiding criticality during the various stages of operation. (auth)

10421 TREATMENT OF RADIOACTIVE WASTES RESULTING FROM THE REPROCESSING OF IRRADIATED FUELS. SOLUTIONS ADOPTED BY J.E.N. I. LIQUID WASTES OF LOW AND MEDIUM RADIOACTIVITY. de Lora Soria, Federico; Diaz Nogueira, Eduardo; Lopez Perez, Baldomero (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid), 10: 280-95(July-Aug. 1966). (In Spanish).

Various ways of processing liquid radioactive wastes of low and medium radioactivity are described. Methods described include hydroxide floccuation, phosphate treatments, coprecipitation of sulfides, and ferrocyanide treatments. Ionic interchanges, biological treatments, and other methods are also considered. The methods adopted by the JEN for the CIES plant are given. (G.O.Y.)

10422 ION FLOTATION. Charewicz, Witold; Niemiec, Jan. Wiad. Chem., 20: 693-709(Nov. 1966). (In Polish).

Basic problems concerning the concentration and partition of ions from dilute aqueous solutions by the application of the ion flotation method, called also Coulomb flotation, are discussed. (auth)

10423 AMALGAM EXCHANGE SEPARATION OF RADIOTHALLIUM. Hahn, Richard B. (Wayne State Univ., Detroit); Kanapilly, George M. Talanta, 14: 129-32(1967).

A method is presented for the rapid separation of ^{204}Tl. The thallium solution is made basic by addition of ammonia, then sodium fluoride and ethylenediamine are added and the mixture is shaken with 3% thallium amalgam. A rapid exchange takes place and the bulk of the activity is concentrated in the amalgam. The amalgam is diluted with clean mercury and shaken with acidic cobalt nitrate solution, which back-extracts thallium. About 90% of the thallium activity is recovered. (auth)

10424 TRIVALENT CERIUM EQUILIBRIA WITH A SYNTHETIC HEULANDITE–CLINOPTILOLITE SERIES ZEOLITE. Ames, L. L. Jr. (Battelle-Northwest, Richland, Wash.). J. Inorg. Nucl. Chem., 29: 262-6(Jan. 1967).

The ion-exchange characteristics of a zeolite prepared from LiOH, ground $Al(OH)_3$, and ground silica gel in the oxide ratio 1:1:12 for $Li_2O/Al_2O_3/SiO_2$ were investigated. Cerium cation exchange capacities and equilibria were determined. The cerium capacities obtained were 1.12, 1.18, and 1.16 m-equiv. Ce/g zeolite. Selectivity data are presented as a graph of cerium selectivity coefficient vs. the ratio of the cube of the normality of nitric acid to the normality of cerium in the equilibrium solution. (M.C.G.)

10425 STUDY ON THE SOLVENT EXTRACTION WITH RADIOTRACERS. I. EXTRACTION STUDY ON ^{233}Pa WITH THENOYLTRIFLUOROACETONE. Chen, Ying-mao (National Taiwan Univ., China). J. Chin. Chem. Soc. (Taiwan), 13: 38-47(Mar. 1966).

^{233}Pa, separated from the irradiated thorium, was used as a tracer for the extraction study with thenoyltrifluoroacetone (TTA). From results obtained by the variation of acidities of HCl with a constant concentration of TTA in benzene, a slope of −2 was obtained by plotting the distribution coefficients against acidities. With a definite acid concentration of HCl in the aqueous solution and by the variation of TTA concentration, a slope of 4 was obtained by plotting the distribution coefficients against the concentration of β-diketone. The species extracted by the organic layer was assumed to be $Pa[TTA]_2[HTTA]_2$. If the composition of the organic layer was changed by the addition of the following solvents into the TTA in benzene solution, the order of the extraction was found as follows: n-amyl alcohol > cyclohexane > chloroform > n-hexane > carbon tetrachloride > benzene > nitrobenzene > hexone > cyclohexanone > n-butyl alcohol. (auth)

10426 THE SOLVENT EXTRACTION OF HAFNIUM(IV) AND ZIRCONIUM(IV) BY N-BENZOYL-N-PHENYLHYDROXYLAMINE AND 2-THENOYLTRIFLUOROACETONE FROM STRONGLY ACIDIC SOLUTIONS. Hala, J. (Univ. of Brno). J. Inorg. Nucl. Chem., 29: 187-98(Jan. 1967).

The extraction of Hf(IV) and Zr(IV) by N-benzoyl-N-phenylhydroxylamine and 2-thenoyltrifluoroacetone from strongly acidic solutions of $HClO_4$ and HCl was studied. It was found that these ions are extracted as $M(IV)X_4 \cdot 2HA$ and $M(IV)A_3X$ (X = ClO_4^- or Cl^-, HA = unionized reagent molecule) by the former and latter reagent, respectively. Some applications of these extraction systems to separation procedures are proposed. (auth)

10427 THE SYNERGIC AND ANTAGONISTIC EFFECTS IN THE EXTRACTION OF INORGANIC COMPOUNDS WITH A MIXTURE OF AMINES AND ORGANOPHOSPHORIC ACIDS. THE SYSTEM: $UO_2^{2+} + H_2SO_4 + H_2O$–TRI-n-OCTYLAMINE + DIALKYLPHOSPHORIC ACID + DILUENT. Deptula, C.; Minc, S. (Inst. of Nuclear Research, Polish Academy of Sciences, Swierk. Inst. of Nuclear Research, Warsaw). J. Inorg. Nucl. Chem., 29: 159-78(Jan. 1967).

It has been found that synergic and antagonistic effects occur during the extraction of uranium(VI) with mixtures of tri-n-octylamine and dialkylphosphoric acids. The influence of the concentration of uranyl sulfate, sulfuric acid, ammonium sulfate, and extractants on the extraction of uranium(VI) with a mixture of tri-n-octylamine and dialkylphosphoric acids has been studied. The composition of the extracted compounds has been determined, and constitutional formulas of these compounds are proposed. The reasons for the synergic and antagonistic effects are explained. (auth)

10428 PRECIPITATION OF URANIUM AND THORIUM FROM FUSED SALTS. Riedel, H. J. (Kernforschungsanlage, Juelich, Ger.). Nukleonik, 8: 425-8(Nov. 1966). (In German).

The chemical behavior of uranyl nitrate, thorium nitrate, uranium carbide, "coated particles", protactinium, and fission products in eutectic melts of KNO_3–$LiNO_3$, K_2CO_3–$LiCO_3$, and KCl–LiCl was investigated. A separation of uranium from thorium was not possible in the K_2CO_3–Li_2CO_3 and KCl–LiCl melts, but was obtained in the $LiNO_3$–KNO_3 melt. A separation from protactinium was also exhibited as a possibility based on the stepwise precipitation of iron, thorium, and uranium in the nitrate melt. Gamma-spectrometric investigations of the process were made and a certain fractionation was exhibited. No chemical action was observed on the carbon-coated UC_2 particles in the three melts at temperatures to 500°C. (tr-auth)

10429 URANIUM(VI) EXTRACTION FROM SULFURIC ACID SOLUTIONS WITH MONO-2,6,8-TRIMETHYLNONYL-4- AND MONO-n-BUTYLPHOSPHORIC ACIDS SOLUTIONS IN BENZENE AND CARBON TETRACHLORIDE. Deptula, C.; Minc, S. (Inst. of Nuclear Research, Polish Academy of Sciences, Swierk. Inst. of Nuclear Research, Warsaw). J. Inorg. Nucl. Chem., 29: 229-40(Jan. 1967).

The influence of the concentration of sulfuric acid, uranyl sulfate, and the extractant on the extraction of uranium(VI) with mono-2,6,8-trimethylnonyl-4- and mono-n-butylphosphoric acids solutions in benzene and carbon tetrachloride was investigated. The composition of the extracted compounds was determined and constitutional formula for the compounds were proposed. (auth)

10430 EXPERIMENTAL METHODS FOR THE DETERMINATION OF THE THERMAL DIFFUSION FACTOR. Vasaru, Gh. (Inst. of Atomic Physics, Cluj). Kernenergie, 9: 301-6(Oct. 1966).

Three methods for the experimental determination of the thermal diffusion factor for isotopic mixtures are reviewed. They are the method of the two reservoirs, swing separator method, and the thermal diffusion column method. Although more elaborate experimental equipment is required, results obtained by the latter two methods are more accurate. (J.G.B.)

10431 SOLAR EVAPORATION OF LOW LEVEL RADIOACTIVE SLUDGE. Bonhote, P. A. (Australian Atomic Energy Commission). At. Energ. Austral., 9: No. 3, 14-17(July 1966).

Solar evaporation was investigated as a method of further processing the sludge (3.5 to 5.0% solids, 10^{-2} μCi/ml) produced from a scavenging/flocculation treatment of low-level effluent at Lucas Heights. Preliminary experiments showed that filters could be dispensed with, and that the sludge could be dried out in the open with little or no contamination spread. A full-size evaporator of 927 ft^2 area was designed to cope with the sludge production of 15,000 gal/yr. The drying proceeds until the sludge can be cut into blocks, and at the end of drying, the blocks are shoveled into drums for burial. The performance in 16 months' operation is described; the volume reduction factor averages 14, and the moisture content of the dried sludge averages 27%. (D.L.C.)

10432 EXTRACTION OF HEXAVALENT URANIUM FROM NITRIC ACID SOLUTIONS BY TETRABUTYLPYROPHOSPHATE (TBPP). Mikulski, J.; Vetulani, J. (Inst. of Nuclear Physics, Krakow. Pharmacological Dept., Krakow). J. Inorg. Nucl. Chem., 29: 209-20(Jan. 1967).

The mechanism of extraction of nitric acid and uranyl ions by tetrabutyl pyrophosphate (TBPP) solutions in carbon tetrachloride has been investigated. The solvation number for the uranyl ion, determined by both extraction and the spectrophotometric method, was one. A reaction of aggregates of the extractant species with the TBPP–uranium complex is suggested. Kinetic investigations of this reaction were carried out recording the absorbance in the P—O stretch band at different times after reaching thermodynamic equilibrium for the primary extraction. The postulated reaction follows a zero order equation when the molar ratio of TBPP and uranium nitrate was 10:1. (auth)

10433 URANIUM(VI) EXTRACTION FROM SULFURIC ACID SOLUTIONS WITH TRI-n-OCTYLAMINE SOLUTIONS IN BENZENE AND CARBON TETRACHLORIDE. Deptula, C.; Minc, S. (Inst. of Nuclear Research, Warsaw. Swierk Inst. of Nuclear Research, Warsaw). J. Inorg. Nucl. Chem., 29: 221-7(Jan. 1967).

The influence of the concentration of uranyl sulfate, sulfuric acid, sodium sulfate and extractant on the extraction of uranium(VI) with tri-n-octylamine solutions in benzene or carbon tetrachloride has been studied. The absorption spectra of the uranium(VI) compounds in aqueous sulfate solutions and in tri-n-octylamine sulfate solutions in benzene and carbon tetrachloride are given. The composition of the extracted compound has been determined. (auth)

10434 THE REPROCESSING INDUSTRY IN EUROPE. Nucl. Eng., 11: 871-4(Nov. 1966).

A review of the European plants, Windscale (U.K.A.E.A.), La Hague (C.E.A.), and Mol (Eurochemic), shows marked differences in organization, scale and type of operations, plant configurations and the general layout of the sites and buildings. A list of Eurochemic's contracts is appended. (UK)

10435 ELECTRODIALYSIS OF ^{106}Ru, $^{56\ 57\ 58}Co$, AND ^{65}Zn IN SEA WATER THROUGH ION-EXCHANGE MEMBRANES. Marazovic, Lj.; Pucar, Z. (Ruder Boskovic Inst., Zagreb). Croat. Chem. Acta, 38: 183-91(1966).

The procedure for studying the migration of microconstituents during electrodialysis of sea water through ion exchange membranes is described. On the basis of experiments with ^{106}Ru the possibility of separating various stable physico-chemical forms of ruthenium from sea water is presented. The separation process was controlled by measuring the radioactivity of sea water during electrodialysis, and the adsorption on ion exchange membranes in order to establish whether various stable physico-chemical forms of ^{106}Ru exist in sea water and whether they can be successfully separated by this method. For comparison of the results, all

experiments were also performed using both $^{56,57,58}Co$ and ^{65}Zn in sea water. (auth)

10436 EXTRACTION OF URANYL SALTS WITH TRI-N-OCTYLAMINE OXIDE. Torgov, V. G.; Mikhailov, V. A.; Startseva, E. A.; Nikolaev, A. V. (Inst. of Inorganic Chemistry, Academy of Sciences, Siberian SSR). Dokl. Akad. Nauk SSSR, 168: 836-9(June 1, 1966). (In Russian).

TOA oxide was obtained by oxidizing pure TOA with concentrated H_2O_2 at room temperature for a period of 20 hours. Distribution isotherms at 25°C were determined between aqueous solutions of uranyl nitrate, uranyl chloride, and uranyl sulfate, and a solution of TOA oxide in chloroform or benzene. The distribution isotherms of uranyl nitrate on extraction with 0.1 M TBP are also given as a basis of comparison. In the region far from where the organic phase is saturated, the TOA oxide extraction coefficient for $UO_2(NO_3)_2$ exceeded that of TBP by 5 orders of magnitude. In this respect TOA oxide possessed the same properties as the trialkyl phosphine oxides. The TOA oxide exists as a dimer at a concentration of 0.05 to 0.1 M in benzene. Maximum uranium extraction was obtained on using benzene as a diluent. The TOA oxide has a high extraction coefficient for uranium, and can effectively extract uranium from a nitrate, chloride, or sulfate solution. A detailed study of the mechanism of extraction of uranyl salts by TOA oxide is being carried out at present. (TTT)

10437 EXTRACTION SEPARATION OF NIOBIUM FROM ZIRCONIUM, TUNGSTEN, URANIUM, AND IRON WITH AMMONIUM TETRAMETHYLENEDITHIOCARBAMATE. Gibalo, I. M.; Alimarin, I. P.; Davaadorzh, P. Vestn. Moskov. Univ., Ser. II: Khim., No. 4, 73-5(1965). (In Russian).

The separation of Nb from Fe, U, W, and Zr consists of forming the Nb complex with the dry reagent ammonium tetramethylenethiocarbamate (I) in a solution of either pH 5 or 9 to 10 N HCl solution and extracting the complex with $CHCl_3$. The test solution is adjusted to the correct acidity with either aqueous ammonium acetate buffer or concentrated HCl, a 20-fold excess of I is added, and after a period of 30 min the solution is extracted with an equal volume of $CHCl_3$. For ratios of $Nb_2O_5 : ZrO_2$ of 1 : 1, complete separation is achieved at pH 5; but with higher concentrations of ZrO_2, the separation must be carried out in 9N HCl. At ratios of $Nb_2O_5 : WO_3$ of 1 : 10, separation is possible only at pH 5. Uranium forms a complex with I in slightly acid media, but satisfactory separation of Nb from U can be achieved in 9N HCl. In an alkaline medium (pH 9), iron forms a complex with I and can be separated from Nb when the ratio of Nb_2O_5 to Fe_2O_3 is $\simeq$ 1 : 100 to 25 : 1. (Analytical Abstr.)

10438 ZIRCONIUM REMOVAL FROM ^{90}Sr. Bray, L. A. (to U. S. Atomic Energy Commission). U. S. Patent 3,301,789. Jan. 31, 1967.

A process is described for removal of Zr from ^{90}Sr by forming a filterable precipitate of $^{90}Sr(CO_3)_2$ by first neutralizing the solution mixture to a pH of 10 by adding caustic material, adding potassium acid carbonate to change the pH to 7, then adding potassium carbonate to raise the pH to 10, and digesting the slurry at a temperature of 80 to 90°C for an extended period of time. (AEC)

10439 CONCENTRATION AND CONTAINMENT OF RADIOACTIVITY FROM RADIOACTIVE WASTE SOLUTIONS IN ASPHALT. Davis, G. D.; Frederick, E. J.; Godbee, H. W.; Holmes, J. M. (to U. S. Atomic Energy Commission). U. S. Patent 3,298,961. Jan. 17, 1967.

A method of concentrating and containing the solid content of an intermediate level radioactive solution comprises mixing the solution with emulsified asphalt, evaporating essentially all of the water from the mixture at a temperature no greater than 160°C, and then flowing the resultant asphalt composition into a container to solidify in a desired configuration. (AEC)

10440 PROCESS FOR THE REMOVAL OF IMPURITIES FROM ACTINIDES. Lindland, Kare P. (to Institutt for Atomenergi). U. S. Patent 3,285,943. Nov. 15, 1966. Priority date May 8, 1962, Norway.

A process is described for separation of fission products consisting of elements having atomic numbers between 30 and 64 and having ion diameters between 1.4 and 2.0 Å from U and Pu by the formation of complexes with the U and Pu and removal of these complexes from the uncomplexed actinides by use of a molecular sieve, or electrodialysis. The complexing step is carried out by adding the complexing agent to an aqueous uranyl nitrate solution containing the dissolved neutron-irradiated uranium. The complexing agent contains polar groups, either hydroxy, ether, ester, keto, or carboxy groups, and is capable of selectively forming molecular complexes of the type $UO_2(NO_3)_n \cdot L_m$ and $Pu(NO_3)_p \cdot L_q$ where L is the complexing agent, n, m, and q are the integers either 1 or 2 and p is an integer either 1, 2, 3, or 4. The complexing agent is taken from the group consisting of diol compounds, triol compounds, nitrogeneous derivatives taken from the group consisting of hydroxylamine, carbamide, triethanolamine, and nitrilotriacetic acid, and ketone derivatives of the type $O=C\begin{smallmatrix}R_1\\R_2\end{smallmatrix}$ in which R_1 and R_2 denote oxygenated hydrocarbon chains. After complexing, the solution is contacted with a molecular sieve having passages with diameters greater than 25 Å and blind pores with diameters between 6 and 12 Å so that the complexed U and Pu molecules pass through the passageways and the uncomplexed fission products enter and are retained in the blind pores. This process also serves as a possible means to solidify fission products directly for waste disposal. (B.L.M.)

10441 APPARATUS FOR SEPARATION AND PURIFICATION OF A MIXED GAS. Jono, Wasaburo (to Kurashiki Rayon Co., Ltd.). Japanese Patent 1965-27522. Dec. 4, 1965. Filed May 6, 1962.

A separator is proposed for the continuous separation on an industrial scale of useful gases from a waste gas by means of thermal diffusion resulting from a temperature gradient between a mixed gas at high temperature and feed water at a lower temperature. The heavier, larger molecules go to the higher temperature side; and the lighter, smaller molecules to the lower temperature side. The gas is introduced in the middle of the gas separator located in a cooling-water tower, causing thermal diffusion between the waste gas of high temperature and the boiler feed water. (TSS)

10442 PROCESS AND APPARATUS FOR THE CONCENTRATION OF RADIOACTIVE SOLUTIONS OR LIQUIDS. Charuit, Pierre; Wormser, Gerald (to Commissariat l'Energie Atomique). U. S. Patent 3,280,887. Oct. 25, 1966. Priority date Apr. 4, 1962, France.

An apparatus is described for the concentration of liquids, particularly radioactive ones, by natural evaporation. The apparatus includes a reservoir for receiving the liquids, a dividing chamber positioned above the reservoir and containing a number of vertically disposed dividing plates mounted within the chamber. The components are so arranged that the liquids flow from the top to the bottom. Conduit means including a pump are provided for conveying the liquids from the reservoir to above the dividing plates and from the bottom of the dividing plates to the reservoir. An expansion chamber above the dividing chamber has a section substantially larger than that of the dividing chamber. A hollow, converging, open ended truncated cone connects the dividing chamber with the expansion chamber, and the expansion chamber has an exit orifice having a section at least as great as the minimum section of the cone. First and second means are provided to circulate air through the dividing chamber in an upward direction with the second fan being mounted at the exit orifice of the expansion chamber. (B.L.M.)

EARTH SCIENCES

Geology

Refer also to abstracts 10484 and 10722.

10443 (NYO-3624-1) ^{129}I AS A GEOCHEMICAL AND ECOLOGICAL TRACER. Progress Report, December 1, 1965–October 31, 1966. Kohman, Truman P.; Edwards, Raymond R. (Carnegie Inst. of Tech., Pittsburgh, Pa. Dept. of Chemistry). Nov. 30, 1966. Contract AT(30-1)-3624. 43p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Studies were made to exploit the natural occurrence of the long-lived ^{129}I (half-life 1.6×10^7 years) expected from spontaneous and induced fission of uranium and from cosmic-ray interactions with the atmosphere, meteorites, and similarly exposed materials, and the somewhat larger quantities introduced into the environment through atomic energy activities. A substantial number of samples of biological, mineral, and commercial iodine-bearing materials, including some collected or processed before 1945, have been acquired. Chemical procedures for pre-irradiation isolation of iodine and post-irradiation preparation for counting have been adapted to the analytical specimens of interest. Many of the specimens have been processed to varying extents. Conditions have been established for the use of an existing γ-γ coincidence detector system for the assay of ^{129}I in relatively large (~gram) samples of iodine, and partially tested following four irradiations of natural and synthetic samples. Specifications have been formulated for a $\beta-\gamma$ coincidence system for the assay of ^{129}I in very small amounts in small (~mg) samples of iodine. (P.C.H.)

10444 (ORNL-TM-1681) STUDY OF THE MOVEMENT OF RADIONUCLIDES THROUGH SATURATED POROUS MEDIA. Shaikh, M. U.; Jacobs, D. G.; Parker, F. L. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 115p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis. Submitted to Vanderbilt Univ., Nashville, Tenn.

A theoretical solution of water flow has been obtained for an inverted five-spot system with the injection well located at the center of a square sandstone slab (6 feet by 6 feet by 6 inches) and four relief wells at the corners of a centered 3-foot square, oriented in the same direction as the edges of the slab. Equations for stream function, potential function, and the velocities in the block have been developed. From the distribution of velocities, in the radial flow and distorted flow, it has been shown that the flow pattern is unaffected by wells up to a distance of 8 inches from the injection well. Equipotential contours, streamlines, and the flow history of the system have been plotted by the computer. From the sorption data obtained from linear flow cores, the time required for the breakthrough of ^{89}Sr and ^{45}Ca has been found to be 8.5 and 6.2 times that of water, respectively. Using different linear flow rates, coefficients of dispersion have been obtained using cores of sandstone. By combining the solution of the velocity distribution attributed to geometry with solution dispersion at various rates of linear flow, net solution breakthrough curves have been constructed. (F.S.)

10445 SELECTION OF GRAZING LAND DISTRICTS ACCORDING TO THE RADIOACTIVITY OF UNDERGROUND WATERS OF UPPER CRETACEOUS PERIOD. Ergashev, S. E. Dokl. Akad. Nauk Uz. SSR, No. 7, 51-3(1966). (In Russian).

Uranium and radium content in underground waters was studied in the artesian basins in the Northwestern part of Middle Asia. Many holes drilled at 140 to 450 m in depth indicated the presence of a connected united Senoman-Turonian water-bearing complex. A schematic distribution of drinking water districts was established considering permissible uranium norms as 5×10^{-6} g/l. (R.V.J.)

10446 RADIOACTIVE TRACING OF STORM RUNOFF ON A SMALL CATCHMENT. II. DISCUSSION OF RESULTS. Pilgrim, D. H. (Univ. of New South Wales, Kensington). J. Hydrol., 4: 306-26(1966).

The use of ^{198}Au and ^{51}Cr for tracing storm runoff on a 96-acre natural catchment is described. Each activity-time record at the catchment outlet provided a hydrograph of outflow of the labeled drop of water. Consideration of these records enabled clarification of the concept of concentration time. Measured values of this time of travel from the point most remote from the catchment outlet were found to depend mainly on the discharge, and also on the duration of rainfall excess. Application of time of travel measurements to a number of hydrograph synthesis methods is discussed. The results also provide information on several aspects of the storm runoff process, including the validity of linear analysis, an apparent partial area runoff production effect, and the distribution of initial loss. (BBB)

10447 RADIOACTIVE TRACING OF STORM RUNOFF ON A SMALL CATCHMENT. I. EXPERIMENTAL TECHNIQUE. Pilgrim, D. H. (Univ. of New South Wales, Kensington). J. Hydrol., 4: 289-305(1966).

A method was developed whereby radioisotopes were used for direct measurement of travel times of storm runoff on a 96-acre natural catchment. The primary objective was to measure the time of concentration, but the flow of water from various representative points on the catchment was also traced. The experimental technique and instrumentation are described. Several problems resulted from the impossibility of predicting heavy rain far in advance and from the field conditions prevailing during flood-producing rain. The methods used for overcoming these problems are outlined. Two radioisotopes, ^{198}Au and ^{51}Cr-EDTA, were used. The requirements and types of tracers are discussed, together with safety aspects of the project and the performance of the tracers. The performance of the ^{51}Cr-EDTA was most satisfactory. (BBB)

10448 GEOCHRONOLOGY AND ISOTOPE GEOCHEMISTRY. Tilton, G. R.; Davis, G. L.; Hart, S. R.; Aldrich, L. T.; Steiger, R. H.; Gast, P. W. (Carnegie Institution, Washington, D. C.). Carnegie Inst. Wash., Pap. Geophys. Lab., No. 1440, 240-56 (Dec. 1964).

Theoretical and practical aspects of the use of U, Th, Pb, Sr, Rb, Ar, and K isotopes for determining ages of minerals and rocks are discussed. Also described is an investigation dealing with the isotopic composition of lead in feldspars and galenas of different ages which suggests a value for the age of the earth somewhat different from the currently quoted one of 4.55×10^9 yr. This value is obtained by comparing the isotopic composition of some modern terrestial lead with that of lead from the troilite phase of iron meteorites, taken to be primordial lead, i.e., the lead present in the earth when it was formed. A $^{207}Pb-^{206}Pb$ age was calculated by assuming that the modern terrestrial lead has evolved from the meteorite lead in a chemically closed system. The isotopic composition of lead from certain rocks cannot be fitted to a closed system growth curve for an earth that is 4.55×10^9 yr old. Instead, it appears that the source for the leads has been enriched in uranium with respect to lead by chemical transport. Allowance for the failure of the closed system condition yields a min age of 4.7×10^9 yr for the earth. Also considered are the isotopic composition of lead in volcanic rocks from the Mid-Atlantic Ridge and the dating of orogenic phases in the Central Alps with K–Ar ages for hornblende. (BBB)

10449 CONCENTRATION OF ^{222}Rn AND ITS DAUGHTER PRODUCTS IN CERTAIN CZECHOSLOVAK MINES. Sevc, Josef; Cech, Jan. Prac. Lek., 18: 438-42(Dec. 1966). (In Czech).

The radiometric investigation was carried out in 22 coal and 12 ore mines from 1962 to 1965. The concentration of ^{222}Rn and its short-term daughter products were investigated; attention was also given to the level of the external gamma radiation. In 11 mines radon concentrations were found which were higher than 30.0 pCi/l and in 8 mines these concentrations were higher than 100 pCi/l. Concentrations of the other substances investigated, as well as the intensity of the external gamma radiation, were very low. According to the Rn concentrations found, a classification of the investigated Czechoslovak mines was proposed. Precautions in the individual groups were recommended, e.g., more intensive ventilation, in certain cases, use of the same technical and hygienic measures as those used in mines of radioactive crude ores. (auth)

10450 CHEMICAL FRACTIONATION AND ITS RELATIONSHIP TO THE DISTRIBUTION OF THORIUM AND URANIUM IN A ZONED GRANITE BATHOLITH. Ragland, Paul C.; Billings, Gale K.; Adams, John A. S. (Rice Univ., Houston, Tex. Univ. of North Carolina, Chapel Hill). Geochim. Cosmochim. Acta, 31: 17-33(Jan. 1967).

Major element and radiometric analyses were performed on 79 samples from the Enchanted Rock batholith, Llano Uplift, Texas. The major element data are in agreement with earlier work that the batholith is not zoned in the classical manner, from more mafic rocks along the margins to more felsic in the core, but rather in a more complex fashion. Evidence is offered to suggest that the magma fractionated before and/or during emplacement rather than after. Anomalously high thorium and uranium values can be correlated with the presence of allanite and abundant sphene, whereas the decrease in uranium content with increasing fractionation may be a result of increasingly effective

oxidative processes during magmatic crystallization. Thus the distribution of thorium and uranium within the batholith is controlled by secondary, rather than primary, processes. (auth)

10451 TEMPORAL AND GEOGRAPHICAL DISTRIBUTION OF RADIUM D (^{210}Pb). Jaworowski, Zbigniew (Inst. of Nuclear Research, Warsaw). Nature, 212: 886-9(Nov. 26, 1966).

Results of an investigation of the temporal and geographic distribution of ^{210}Pb in glacier ice, red deer antlers, and lichens are presented. It is shown that the concentration of ^{210}Pb in the biosphere fluctuates with time and that this may be due to both natural and artificial causes. (W.D.M.)

10452 THE ^{234}U/^{238}U-RATIO IN WATERS AND BOTTOM SEDIMENTS OF THE ARAL SEA AND THE ABSOLUTE AGE OF THE BASIN. Chalov, P. I.; Merkulova, K. I.; Tuzova, T. V. (Inst. of Physics and Mathematics, Academy of Sciences, Frunze, Kirghiz SSR). Geokhimiya, No. 12, 1431-8(Dec. 1966). (In Russian).

The results of ^{234}U/^{238}U ratio study in waters and bottom sediments of the Aral Sea are reported. One the basis of ^{234}U decayed data the absolute age of the Aral Sea (139 ± 12 thousand years), the upper limits of the date of the Amu Darya bend towards the Aral Sea and the Minor Sea existence (22 thousand years) have been established. (auth)

10453 LEAD ISOTOPES AT DUGALD RIVER AND MOUNT ISA, AUSTRALIA. Richards, J. R. (Australian National Univ., Canberra). Geochim. Cosmochim. Acta, 31: 51-62(Jan. 1967).

Solid-source mass spectrometer lead-isotope studies show that, although Dugald River Prospect, Queensland, and Broken Hill, New South Wales, are over 800 miles apart, they appear to have been derived from sources very similar in U–Th–Pb relative abundances. However, whereas the Broken Hill deposit is uniform in isotopic make-up, some Dugald River samples show small variations. All Dugald River samples differ slightly from the uniform lead at Mount Isa, 60 miles to the southwest, where lead disseminated in the copper host-rock is isotopically indistinguishable from the nearby lead orebody. Confidence limits for these and other available solid-source data are compared with a comparable set of gas-source lead isotope results. Evidence of instrumental bias is seen, emphasizing that direct comparison of solid-source data with the "conformable growth curve" is not justified without correction to a common standard. (auth)

10454 NOMOGRAM FOR THE DETERMINATION OF THE DATE OF FORMATION OF MIXTURES OF RADIOACTIVE ISOTOPES. Varyushchenko, S. B. Radiokhimiya, 8: 611(1966). (In Russian).

A nomogram was constructed for determining the date of formation for radioactive mixtures. (J.S.R.)

10455 RADIOMETRIC SURVEY WITH A CAR-MOUNTED INSTRUMENT IN THE EASTERN PART OF AICHI PREFECTURE. Horikawa, Yoshio; Obi, Nakamaru. Chishitsu Chosasho Geppo, 16: 148-60(Mar. 1965). (In Japanese).

A radiometric survey of naturally occurring radioactivity in the eastern part of Aichi prefecture was carried out with a car-mounted scintillation counter in December 1962 and March 1963. The car-mounted scintillation counter consisted of a detector equipped with a NaI (Tl) crystal 5 in. in diameter and 2 in. thick. Background radioactivity was 400 to 450 counts/sec in the environment. Anomalies of radioactivity were found in the Neogene Tertiary sediment at Toki city, Gifu prefecture. One anomaly was due to the exposure of a uraniferous deposit on a hill and amounted to 3500 counts/sec; another was due to exposure at a drain on a highway and amounted to 1700 counts/sec. Assay of sediment samples from the area revealed a U_3O_8 content of 0.1% which indicated that the area may be suitable for uraniferous deposit prospecting. In the eastern part of Mizunami city, a highly radioactive area of freshly exposed biotite granite was located. Radioactivity was thought to be due to contamination coming through cracks from eroded or buried uraniferous deposits. Radioactive content of granitic rocks was studied from intensity tracings along fresh outcrops of rocks and by lab measurement of total γ intensity. The biotite granite distributed in the northern part of the area surveyed was more radioactive than the Ryoke-type granite in the southern area. The northern area surveyed is overlain by the Neogene Tertiary sediment in which the radioactive anomalies were observed. (BBB)

10456 RADIOMETRIC SURVEY WITH A CAR-MOUNTED INSTRUMENT IN THE SOUTHERN PART OF YAMAGATA PREFECTURE. Horikawa, Yoshio; Ujiie, Akira. Chishitsu Chosasho Geppo, 16: 141-7(Mar. 1965). (In Japanese).

A car-mounted scintillation counter equipped with a NaI crystal (5 in. diam., 2 in. thick) was used to conduct a radiometric survey in the southern part of Yamagata Prefecture, Japan. Background radioactivity counts were 400 to 450 counts/sec in this environment. The granite rocks in the explored area generally showed a radioactivity of about 500 to 800 counts/sec at exposures along the road. Granitic rocks of the area were found to be medium in radioactive content as compared with those in Northeast Japan. An increased count of about 1000 counts/sec was found in the Neogene Tertiary sediment in the Hakutaka-cho, Nishioitamagun Yamagata Prefecture. This area would be appropriate for selective studies on terrestrial radioactivity. (BBB)

10457 KINETICS OF CESIUM SORPTION BY CLAY MINERALS. Sawhney, B. L. (Connectituct Agricultural Experiment Station, New Haven). Contract AT(30-1)-2955. Soil Sci. Soc. Amer., Proc., 30: 565-9(Sept.-Oct. 1966).

Time course and the processes in the sorption of ^{137}Cs from dilute solutions by illite, montmorillonite, and vermiculite saturated with Ca or K and in the absence of excess saturating cation were investigated. Cesium sorbed by illite and montmorillonite quickly reached an approximate equilibrium: the ^{137}Cs sorbed by montmorillonite did not change with time while the ^{137}Cs sorbed by illite changed only slightly. On the other hand, the ^{137}Cs sorbed by vermiculite did not reach an equilibrium even after 500 hr. Cesium sorbed by Ca-vermiculite continued to increase while the ^{137}Cs sorbed by K-vermiculite decreased. Since the sorption of ^{137}Cs by illite is limited to the external planar surfaces and interlattice edges only, equilibrium is quickly reached. Equilibrium in montmorillonite is attributed to its expanded lattice which makes all exchange sites equally available and permits exchange readily. The increased ^{137}Cs sorption by Ca-vermiculite, on the other hand, is attributed to the different sorption rates by different exchange sites: initial fast sorption on external surfaces and edges followed by slow diffusion into the interlayers. The decreased ^{137}Cs by K-vermiculite is perhaps associated with the collapse of the partially hydrated vermiculite in suspension to 10 Å. (BBB)

10458 DEPENDENCE OF THE ENERGY OF ACTIVATION OF RADIOGENIC GASES IN MINERALS ON TEMPERATURE. Brandt, S. B.; Voronovskii, S. N. (Dagestan Branch, Academy of Sciences, USSR). Geochem. Int., 1: 302-5(1964).

The effect of diffusion on the amount of radiogenic argon in a mineral as a function of time was discussed. To estimate the effect of diffusion it is necessary to know the coefficient of diffusion (D) at the temperatures characterizing the environment of the minerals and rocks which are being measured. These temperatures usually do not exceed 100 to 150°C. Measurements of the values of D at these temperatures under laboratory conditions are impossible because present-day instruments are not sufficiently sensitive. It is customary to determine the value of D at much higher temperatures and then extrapolate to the lower temperature by the formula: $D = D_0 \exp[-(E/RT)]$, where E is the activation energy of diffusion. According to this equation, log D plotted in coordinates (log D, T^{-1}) varies with a slope of $\tan^{-1}(-E/R)$. Evidently, the constancy of E/R is the main requirement for the extrapolations which usually extend over several logarithmic orders of D. A method of checking the linear dependence (log D, T^{-1}), by comparing calculated and measured content of radiogenic argon in mineral samples heated through a certain temperature range, was developed. To investigate the relation between E and temperature in a given interval it was necessary to determine the dependence of the content of radiogenic argon in the sample on time at 2 points near the upper limit of the temperature interval where values of D and E are easily determined by the usual methods. Then, using this equation and the planimetric value of D, it was possible to calculate the Fourier factor for a temperature cycle which includes the temperature interval under investigation. The planimetric value of D was determined essentially by the low temperature region of the interval. This method was applied to samples of Solikamsk sylvite and of muscovite. The sylvite sample was subjected to cyclic heating with temperature and time being recorded automatically. The calculated value for the amount of remaining radiogenic argon was 0.183 ± 0.01 mm^3/g and the experimental value, 0.178 ± 0.005 mm^3/g. The value of 18.4 kcal/mole was used for the activation energy in the 200 to 480°C interval. The same experiment was performed with muscovite. The results showed that there is no change in the activation energy within the experimental temperature ranges either in sylvite or in muscovite. The experimental temperature range can be extended by increasing the duration of heating and the sensitivity of the measuring instruments. (BBB)

10459 LABORATORY INVESTIGATIONS OF THE DETERMINATION OF THE NONACTIVE CARRIER INFLUENCE ON THE MEASUREMENT OF WATER FILTRATION HORIZONTAL VELOCITY BY MEANS OF RADIOACTIVE ^{131}I. Padzik, Andrzej; Niemczynowicz, Janusz (Przedsiebiorstwo Hydrogeologiczne, Warsaw). Nukleonika, 11: 651-8(1966). (In Polish).

Methods for determining water filtration velocity in the soils are reviewed briefly. The radiometric single-well method of

filtration velocity measuring has been considered in more detail. The nonactive carrier injection influence on the sorption of tracer in the soil was also examined. Application of this measurement method gives better precision and also facilitates interpretation of the results. (auth)

Meteorology

Refer also to abstracts 10860–10862, 10868–10870, 12146, and 12255.

10460 (AD–642421) ESTIMATING THE IMPORTANCE OF INDIVIDUAL RADIONUCLIDES IN FISSION AND INDUCED PRODUCT MIXTURES. LaRiviere, Philip D. (Stanford Research Inst., Menlo Park, Calif.). June 1966. Contract N228-(62479)69928. 18p. CFSTI $3.00 cy, $0.65 mn.

A method for estimating the time at which the contribution to the fission-product radiations of an individual fission or induced product is at a maximum is described. The magnitude of the contribution may also be found by simple hand calculations from the expressions derived. (auth)

10461 (IDO–12057) METEOROLOGY FOR THE LOSS OF FLUID TEST REACTOR. Progress Report, December 1964–December 1965. Dickson, C. R. (ed.) (Idaho Operations Office (AEC), Idaho Falls). Nov. 1966. 80p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress is reported on practice forecasting of "Go" versus "No Go" for LOFT, prediction of southwest winds at TAN, descriptions of trajectories of radar-tracked tetroons, and turbulence statistics derived from these trajectories. Studies on the comparison of winds at TAN and Howe to predict effluent trajectories from TAN to Howe, correlation of winds at LOFT-IET, climatological predictions of best start time for each season for LOFT, persistence of stability classes, windspeed, and wind direction, 700-mb air parcel trajectories to different United States border regions, bivane angle variation characteristics as a function of sampling time, and effluent trajectories from LOFT predicted from "most usual" winds are discussed. Special studies comprising photography of smoke plumes at night, likelihood of critically cold temperatures on the EBR II containment vessel, diffusion of long-period releases of uranine dye, comparison of numerical methods solutions of the K-theory equation and the Chamberlain formula for plume depletion under stable conditions, calculation of maximum hourly average relative concentration (χ/Q) for release periods from 1 hour to 4 weeks, and description of new studies are also reported. A statement of the future objectives is presented following the discussion of each subject. (auth)

10462 (NP–16438) MESURE DE LA RADIOACTIVITE NATURELLE DE L'AIR EN ALTITUDE A L'AIDE D'UN BALLON CAPTIF. (High-Altitude Measurements of Natural Radioactivity). (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [1965]. 5p. (In French). Dep. mn.

Sampling devices used to measure natural radioactivity up to altitudes of 1km are described. The method of attaching the devices to a balloon is described. (J.S.R.)

10463 (ORO–2529-6) ATMOSPHERIC RADIOCHEMISTRY. Annual Progress Report. (Arkansas Univ., Fayetteville. Dept. of Chemistry). Dec. 31, 1966. Contract AT(40-1)-2529. 73p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported on studies of: time interval between nuclear detonation and formation of single fallout particles; cosmic-ray-produced ^{28}Mg in rain; global circulation of nuclear debris from May 14, 1965, nuclear explosion; and radioactive Sr, Ce, and Mn isotopes in the atmosphere. Volatile fission products and those with gaseous or volatile precursors were found to be highly depleted in single fallout particles from the May 9, 1966, Chinese nuclear explosion. It appears that about 30 to 40 sec elapsed between the time of nuclear detonation and the beginning of formation of the particles. The existence of cosmic-ray-produced 21.3-hr ^{28}Mg in rain at concentrations of 1.7 and 6.1 × 10^{-1} atoms/cc was established radiochemically by isolating this nuclide from several hundred liters of rain samples collected at Fayetteville (94°W, 36°N), Arkansas. The highest concentrations of ^{90}Sr and ^{144}Ce in air, 5.37 and 122 dpm/SCF, respectively, were found in April 1963, at 64–70°N and at an altitude of 16.7 km. The highest concentration of ^{54}Mn, 11.2 dpm/SCF, was observed in April 1963, at 65°N and at an altitude of 10.6 km. The bulk of ^{54}Mn produced in the Soviet nuclear detonation in October 1961, appears to have reached the troposphere in the spring of 1963. (P.C.H.)

10464 (RME–147) USAEC AIRBORNE RADIOMETRIC RECONNAISSANCE IN ARIZONA, CALIFORNIA, NEVADA AND NEW MEXICO, 1953 TO 1956. (Grand Junction Office (AEC), Colo. Production Evaluation Div.). Aug. 1966. 73p. Dep. mn. GPO $0.75.

The results of an airborne radiometric surveying program conducted in Arizona, California, Nevada, and New Mexico from 1953 to 1956 are compiled as 64 airborne anomaly location maps. Three ground survey maps are included. (L.C.L.)

10465 (RME–148) USAEC AIRBORNE RADIOMETRIC RECONNAISSANCE IN ARKANSAS, COLORADO, MONTANA, TEXAS AND UTAH, 1952 TO 1955. (Grand Junction Office (AEC), Colo. Production Div.). Aug. 1966. 59p. Dep. mn. GPO $0.70.

The results of an airborne radiometric surveying program conducted in Arkansas, Colorado, Montana, Texas, and Utah from 1952 to 1955, are compiled as 50 airborne anomaly location maps. Seven ground survey maps are included. (L.C.L.)

10466 (RME–149) USAEC AIRBORNE RADIOMETRIC RECONNAISSANCE IN SOUTH DAKOTA AND WYOMING, 1952 TO 1955. (Grand Junction Office (AEC), Colo. Production Evaluation Div.). Aug. 1966. 82p. Dep. mn. GPO $1.00.

The results of an airborne radiometric surveying program conducted in South Dakota and Wyoming, from 1952 to 1955, are compiled as 63 airborne anomaly location maps. (L.C.L.)

10467 CIRCULATION OF THE ATMOSPHERE. Lorenz, Edward N. (Massachusetts Inst. of Tech., Cambridge). Amer. Sci., 54: 402-50(Dec. 1966).

Theories concerning circulation of the atmosphere, of interest in relation to distribution of fallout radionuclides, are examined. A problem to the fluid dynamicist is that of deducing the circulation which will take place in a fluid system when it is heated. The atmosphere itself is a special fluid, and it is heated more strongly by the sun in equatorial and tropical latitudes than in temperate and polar latitudes. The circulation of the atmosphere has been deducted from basic principles, such as the mass, radius, and angular velocity of the earth, the total mass and composition of the atmosphere, and the intensity and spectral distribution of the radiation from the sun. The motions of global scale (trade winds and prevailing westerlies at low levels, upper-level westerlies which culminate in the jet stream, and the intertropical convergence zone) form the general circulation of the atmosphere. Migratory cyclones and anticyclones and accompanying upper-level troughs and ridges, and at lower latitudes the tropical hurricanes, are classified as secondary circulations. One of the earliest concepts assumed that the excess solar heating in lower latitudes would bring about a general rising motion in lower latitudes and sinking in higher latitudes, the circuit being completed by a general equatorward motion near the earth's surface and a poleward motion aloft. The large-scale currents were assumed to behave independently of any secondary circulations. By 1950 upper-level wind observations in the northern hemisphere indicated that the secondary systems, and particularly the upper-level troughs and ridges, transported enough angular momentum across the 30th parallel to maintain the prevailing westerlies north of there against the dissipative effects of friction. It is believed that this revised picture of the circulation does not explain why the trade winds and prevailing westerlies exist, and why they are found in their observed locations. Model experiments indicate that secondary systems of the observed intensity, and particularly the migratory ones, occur because simpler circulation patterns, although mathematically possible, are unstable. (BBB)

10468 DISPERSION OF RADIOACTIVE WASTE AIR IN THE ATMOSPHERE AND THE RESULTING ENVIRONMENTAL CONTAMINATION. Vogt, K. J. (Kernforschungsanlage, Juelich, Ger.). Kerntechnik, 8: 453-8(Oct. 1966). (In German).

The dispersion of released activities in the atmosphere is discussed on the basis of the theory of turbulent diffusion. Formulas are given for the activity distribution in the atmosphere, the decrease of the cloud activity by radioactive decay and by washout and fallout effects, the deposition on the ground and the γ-dose from the cloud. The equations are solved numerically using the meteorological parameters recommended by Pasquill. The results are presented as graphs and nomograms. The effective stack height resulting from plume rise by the effluent velocity and the heat emission, and the influence of additional turbulence generated by buildings and forests and of the downdraft and downwash effects are discussed. (auth)

10469 ATTACHMENT OF RADIOACTIVE ATOMS AND IONS TO AEROSOL PARTICLES. Baust, Emil (Univ., Heidelberg). Z. Phys., 19 : 187-206(1967). (In German).

The attachment of radioactive atoms and ions to spherical aerosol particles was studied theoretically. For uncharged atoms the deposition is considered to be solely governed by thermal diffusion. With calculations based on the "limiting-sphere"-method of Arendt–Kallman it is found that the attached activity is proportional to Φ^2 for aerosol particle diameters Φ smaller than 0.1 μm and proportional to Φ for Φ greater than 1 μm. For charged ions the diffusion process is modified by the influence of electrostatic

forces between the diffusing ions and the aerosol particles. In the frequently occurring case of a symmetrically bipolar charged aerosol this influence can be expressed by a function $G_p(\Phi)$, which depends on the diameter Φ and the effective number p of elementary charges on the aerosol particle. For an aerosol particle diameter Φ greater than 0.1 μm the attached activity is proportional to $\Phi^{1.1}$, and for Φ smaller than 0.01 μm it is proportional to $\Phi^{1.55}$. The effects of neglecting various terms in the calculation are considered. The distribution of natural radioactivity on atmospheric aerosols was calculated for various particle size distributions according to Junge. The calculation shows that about 90% of the total natural activity should be attached to particles smaller than Φ = 0.5 μm, and about 35% to particles smaller than Φ = 0.1 μm. The time $T_{\frac{1}{2}}$, in which the concentration of the radioactive particles decreases to half the initial value, depends on the concentration of the aerosol particles and on their size distribution. For 10^4 aerosol particles per cm^3 and the size distributions mentioned, $T_{\frac{1}{2}}$ varies between 15 and 30 seconds for radioactive ions. For radioactive atoms $T_{\frac{1}{2}}$ is greater than it is for ions in the range of aerosol particle diameters below Φ = 0.25 μm, and smaller if Φ greater than 0.25 μm. (auth)

10470 TRACKING RADIOACTIVITY FROM THE AIR. Story, E. J.; Trundle III, A. S. Instrum. Contr. Syst., 39: 105-8(Nov. 1966).

Procedures and instrumentation used in monitoring of airborne radioactive effluent from the Atomic Energy Commission's Nevada Test Site are described. Primary mission of the operators and equipment is tracking airborne radioactivity. Ground areas over which the effluent passes are surveyed to determine levels of radioactivity on the ground. Underground nuclear tests at the Nevada Test Site occasionally, through accident, release small amounts of radioactivity to the atmosphere. Sensitive γ radiation detection and measurement instrumentation is provided in the aircraft, plus an aircraft-positioning system (including Doppler-radar navigation instrumentation) with a track-navigation computer system and a radar altimeter. Gross-count data are recorded automatically or manually with simultaneous recording of aircraft position. A 400-channel pulse-height analyzer provides spectral data which assist in identifying specific radioactive contaminants, necessary for assessment of hazards. The system can detect and track airborne nuclear debris, and delineate fallout patterns on the ground, provide related meteorological information, collect air samples with preliminary in-flight evaluation, and identify radioisotopes. Aircraft position is determined by relation to a fixed ground checkpoint. Heading, ground speed, and drift angle signals are fed into a track-navigation computer, which supplies position data to an analog-to-digital converter. Results are then directed to the information printout subsystem. Data presentation and interpretation are illustrated and discussed. Count-rate data are indicated at selected points along the track. Representative count rates above the background rate are included. These data can be converted to dose rate by either source-calibration or energy-flux techniques. Dose-rate and γ-ray-spectra data vs altitude have been accumulated from 3 to 5000 ft with an overlap from the ground secured data of 3 to 100 ft over a wide area of fallout from D + 1 to D + 30 days. These data, in conjunction with the calibrations for extended ^{137}Cs and ^{60}Co sources, allow the 500-ft gross-count rates to be interpreted in terms of ground dose rate for smooth terrain, or quantity of contamination per unit ground area for areas of special interest. (BBB)

10471 SOME REMARKS ON SIMULTANEOUS MEASUREMENTS OF PARTICULATE CONTAMINANTS INCLUDING RADIOACTIVITY AND ISOTOPIC COMPOSITION OF PRECIPITATION. Bleeker, W.; Dansgaard, W.; Lablans, W. N. (Royal Netherlands Meteorological Inst., De Bilt. Oersted Inst., Copenhagen). Tellus, 18: 773-85(1966).

Results of simultaneous measurements of trace substances in rain sampled during the passage of precipitation systems are discussed. The pattern of the concentrations for particulate matter is compared with that for the ^{18}O and deuterium isotopes. The variations in the concentration have been investigated for various synoptic situations. (auth)

10472 CONTRIBUTION TO THE STUDY OF THE PENETRATION OF AEROSOLS IN FILTERS. Madelaine, G.; Parnianpour, H. (CEN, Fontenay-aux-Roses, France). Ann. Occup. Hyg., 10: 31-8(Jan. 1967). (In French).

A simple method is described for studying the penetration of aerosols into the interior of various types of filters in common use, with particular regard to alpha emitters. Coefficients of absorption were determined. Measurements were confined mainly to the "active deposits" of radon and thoron, which are always present in the atmosphere and usefully serve as tracers for the study of natural aerosols. (UK)

10473 RESULTS OF MEASUREMENTS AND ANALYSES OF NUCLEAR FALLOUT UP TO THE BEGINNING OF 1965. Santholzer, V. (Charles Univ., Hradec Kralove, Czech.). Czech. J. Phys., 15: 506-12(1965).

As a result of the cessation of nuclear tests in the atmosphere there was a further decrease in the activity of dry fallout and rainout, as well as in ground level air, in 1964. The daily activities decreased to the order of tenths of mCi/km^2. From April to August an increase in the activity was again seen, which was caused by the descent of radioactive dust from the stratosphere to the troposphere as a consequence of meteorological factors. Seasonal variation was not so pronounced in 1964 as in 1963, when the activity increased in May and June to 6 or 7 times that of February and March. In 1964 the activity increased 3 fold. The concept of the existence of a stratospheric reservoir of artificial radioactivity, formed as a result of nuclear tests, was thus confirmed, as was the existence of a certain residence time of radioactive dust in the stratosphere. The mean residence time was calculated from the decrease of ^{90}Sr, separated by radiochemical analysis. The mean value of the residence time was 1.6 yr, which indicates a reservoir in the upper stratosphere. The Chinese atomic bomb explosion in October 10, 1964, was not detectable in Hradec Kralove fallout samples. However, in samples from Slovakia a small amount of fresh $^{95}Zr-^{95}Nb$ was detected spectrometrically. It was impossible to detect a decrease of activity in the samples from October and November 1964, because the background from the megaton tests in 1962 was still relatively strong. (BBB)

10474 CHA-PA OBSERVATORY ATMOSPHERIC ELECTRICITY AND RADIOACTIVITY DATA 1958–1959. Teisseyre, Roman (ed.). Lodz, Poland, Polish Scientific Publishers, 1965. 153p.

Data on atmospheric electric potential gradients and radioactivity are presented. The observatory is comprised of meteorological, aerological, and magnetic equipment to make measurements on atmospheric electric potential and radioactivity in the air and in precipitation. Data are compiled monthly on meteorological information, radioactivity in the air and precipitation, and on the potential gradient of the atmospheric electric field. (F.S.)

Mineralogy

10475 SOME CHARACTERISTICS OF ROLL-TYPE URANIUM DEPOSITS AT GAS HILLS, WYOMING. King, John W.; Austin, S. Ralph (Atomic Energy Commission, Grand Junction, Colo.). Mining Eng., 18: 73-80(May 1966).

Differences were noted in barren ground on opposing sides of linear trends of U deposits, and in ground remote from ore, in the Gas Hills district, Wyoming. Most of the ore occurs in roll deposits along a narrow zone of richly to moderately mineralized ground adjacent to elongated solution fronts. The ore is bounded sharply by the front on the barren interior side. On the exterior side, it grades to protore having the characteristics of mineralized ground but lacking the intense mineral deposition. Samples having a relation to the roll structure provided a visual, mineralogical, chemical, and isotopic basis for distinction among the 3 types of barren ground. The barren interior is bleached gray in contrast to the brown cast and brown limonitic specks on the mineralized side of the front. Pyrite in the barren interior has discrete euhedral crystals as contrasted to aggregates of subhedral crystals in the mineralized ground. Remote barren ground is characterized by detrital magnetite. Sulfate, Fe, total S, $CaCO_3$, CO_2, organic C, loss on ignition, and Se are diagnostic; all, except Se, are more abundant on the mineralized side of the front. Depletion of ^{34}S is extreme in the barren interior as the result of fractionation by bacteria; ^{34}S becomes abruptly less depleted across the front, and the isotopic ratio gradually approaches the meteoritic standard in the protore section. Isotopic composition bears only slight relation to the amount of S present. These features indicate that the solution front defines a zone of intense bacterial and chemical activity. Carbon and S were doubtless essential to mineralization, which is believed to have been a biogeochemical process. The ability to determine position relative to the solution front on the basis of the distinguishing features of the barren ground, bounding or remote from ore, serves both to identify and to enlarge the exploration target. (BBB)

10476 URANIUM AND RADIUM GEOCHEMISTRY IN DERNPODSOLIC SOILS OF BELORUSSIA. Gurskii, G. V.; Tikhonov, S. A. (Inst. of Zoology, Minsk. Ministry of Agriculture, Belorrussian SSR). Dokl. Akad. Nauk BSSR, 10: 763-5(Oct. 1966). (In Russian).

The distribution and forms of radioactive U and Ra elements

in turf-clays of Belorussian soil, developed in glacial and water-glacial sand-clays and loess formations of the quaternary period were studied. The tabulated data showed that U and Ra content in Belorussian turf-clay soils vary from 0.2×10^{-4} to 5.0×10^{-4}% U and 0.9×10^{-11} to 4.83×10^{-10}% Ra. (R.V.J.)

10477 THE PROSPECTING AND EXPLOITATION OF URANIUM RESOURCES IN SPAIN. Martin-Delgado Tamayo, Juan. Energ. Nucl. (Paris), 8: 489-93(Nov. 1966). (In French).

The uranium situation in Spain is discussed, and the selection of zones and the organization of prospecting campaigns are studied. Following an analysis of the organization of the Geology and Mine Section of the Junta de Energia Nuclear, the situation in various geological regions is defined and the uranium sources in Spain are classified according to the cost. (auth)

10478 THE SEARCH FOR URANIUM IN AUSTRALIA. Stewart, J. R. (Australian Atomic Energy Commission). At. Energ. Austral., 9: No. 3, 22-32(July 1966).

A historical account is given of the search for U in Australia since 1944. The exploration program of the Commonwealth Government and the roles of the State Mines Departments and private enterprise are described. The deposits in South Australia, Northern Territory, Queensland, New South Wales, Western Australia, Tasmania, and Victoria are discussed in some detail. (D.L.C.)

10479 CONTRIBUTION TO THE RECOGNITION OF THE URANIFEROUS MINERALS OF CALABRIA. THE METAUTUNITE OF S. GIOVANNI IN FIORE. Burragato, F. Period. Mineral., 35: 387-97(1966). (In Italian).

A sample of rock from a depth of 3 m from the region of S. Giovanni in Fiore, Calabria, consisted of a granite mineralized with sulfides and encrusted with a yellow micaceous mineral. The indexes of refraction of this yellow mineral and other optical characteristics were compared with those of metautunite from Daybreak Mine, Washington. Spectrochemical and x-ray fluorescence analysis indicated that the mineral contained P, Ca, and U. Lattice constants, a = 6.993 Å, c = 8.462 Å, a/c = 1.210, were in close agreement with those reported for metautunite from Beintema and Volborth. Powder patterns (Cu K_α) were compared with data for metautunites from France, Washington, and Portugal. The differential thermal analysis curve is reported and powder patterns from samples heated to 125°C, and to 225°C, and hydrated samples from 2 sources, are tabulated. (BBB)

10480 URANIUM: AEC'S SURVEY OF EXPLORATION INDICATES HOW MINING IS RESPONDING TO U_3O_8 DEMAND. Eng. Mining J., 167: 84-7(Nov. 1966).

Results of a survey based on a questionnaire sent to 24 major companies relating to planned U exploration are analyzed. In the next 3 yr, U producers plan exploration and development drilling in the U.S. at a rate of 6 million ft per yr. This is nearly 3 times the level planned a year ago. It is comparable to the average rate of drilling during the 1950 to 1960 decade. In the history of the U.S. uranium industry, dating from 1948, producers have located an average of 8.5 lb of U_3O_8 per ft of hole drilled. Whether this discovery rate can be maintained or will drop will require 2 to 3 yr to determine. The projected increase in drilling is considered high, since any ore found now will probably not be marketable until 1975. There is doubt, however, whether the rate is adequate to support an 8-yr reserve ahead of expanding nuclear reactor requirements. It is estimated that a company must spend at least $1.2 million on exploration and development before it will be able to begin producing U from a deposit 700 ft deep, compared with $800,000 for one that is 200 ft deep. Drilling costs are highly variable and may range from 35¢ per ft up to $2 to $3 per ft for typical ore bodies. Initially, producers will concentrate on the known ore environments in the 3 established major producing districts of the U.S., which include the Gas Hills and Shirley Basin areas of Wyoming, the Uravan belt and Big Indian Wash of Colorado and Utah, and the Ambrosia Lake district in New Mexico. Much exploratory activity is taking place in Wyoming. Present and planned drilling operations in Wyoming are examined in detail. (BBB)

10481 URANIUM: U_3O_8 RESOURCES ABUNDANT BUT UNDEFINED. Eng. Mining J., 167: 80-3(Nov. 1966).

Data are presented on U ore reserves, particularly in the U.S. and Canada. More than 85% of the known Free World reserves of U_3O_8 producible at a price of $5 to $10 per lb are located in the U.S., Canada, and South Africa. Free World reserves of U_3O_8 are placed at 690,000 ton based on a $5 to $10 price range. Possible additional Free World resources were estimated at 680,000 tons. Estimated U.S. reserves are 145,000 tons of 0.235% U_3O_8, including some 20,000 tons of U_3O_8 recoverable as by-product phosphate ores within the $5 to $10 range. The U.S. reserves for the $5 to $10 range are contained in a comparatively few large deposits and many small deposits. The largest 120 (10% of the total number) contain over 90% of the reserve. These zones are relatively shallow. Over 90% of the reserve is in deposits less than 800 ft deep, and 50% is in deposits less than 350 ft deep. About 50% is mineable by open-pit methods. About 60% is in the Colorado Plateau and about 35% in the Wyoming basins. Sedimentary strata of sandstone, mudstone, and limestone are the chief ore sources. Other U.S. U resources include phosphate rock of the western phosphoria formation (including portions of Idaho, Montana, Wyoming, and Utah), Florida phosphates, western coals, and Chattanooga shales. Grade and tonnage are summarized. Potentially, 1000 tons of U_3O_8 might be recovered from an estimated 8-million tons of phosphate rock converted to acid in 1965. By 1975, 1500 to 2000 tons of U_3O_8 per yr could conceivably originate from this source. Canada has the largest known U reserves in the world in the $5 to $10 price range. Reserves in the conglomeratic deposits in the Elliot Lake–Blind River area of Ontario constitute 93% of the total in Canada. Reserves in other countries of the world are considered, as is the potential source of U in the sea. (BBB)

10482 URANIUM: DEMAND WILL TAX RESERVES AND PRODUCTION. Eng. Mining J., 167: 77-9(Nov. 1966).

The influence of greatly increasing demands for U for commercial nuclear power plants on U reserves and production is assessed, the adequacy of reserves is considered, and prospects of reactor technology developments as applicable to these questions are discussed. The most recent median estimates indicate that installed U.S. commercial nuclear electric generating capacity, now rated at about 1167 MW(e), will increase 8⅓ times by 1970, almost 34 times by 1975, and 81 times by 1980. At the end of the period it is forecast that 28,000 ton/yr of U_3O_8 concentrates will be needed to handle the demand for fueling the utilities. The projected 1980 nuclear power capacity will require 172,000 tons of U_3O_8 for the domestic market and 237,000 short tons for the market outside the U.S. The estimated U.S. reserves were 145,000 tons in January, 1966. Contract deliveries of 10,000 tons in 1966 plus future contracted deliveries through 1970 will require another 32,500 tons. This leaves ~102,500 tons of uncommitted U reserves available for the post-1970 period. With an adequate exploration effort, it is estimated that another 325,000 tons of U_3O_8 can be found and developed at prices of $5–10 per lb. Thus, the amount of U_3O_8 available for commercial power development will be 425,000 tons. If a factor of 5 tons of U_3O_8 is assigned to each installed MW(e) of nuclear electric generating capacity, the amount of U needed for 1975 is 200,000 tons. U.S. raw materials producers can apparently compete in the foreign market for U_3O_8 concentrate. It is estimated that private contracts for sale of concentrate now amount to 6000 to 7000 tons of U_3O_8 for delivery by 1971, and a like amount for delivery about 1975. Development of breeder reactors, which produce more fissionable material than they consume, will effect U_3O_8 requirements. However, the breeder reactor is not likely to have any major effect on requirements within the next 15-yr period. Some long-term projections have shown a leveling off and decline in U needs toward the end of the century. (BBB)

Oceanography

10483 RADIOACTIVE CONTAMINATION IN THE HARBOURS OF SASEBO AND YOKOSUKA. Yamagata, Noboru (Inst. of Public Health, Tokyo); Iwashima, Kiyoski. Koshu Eiseiin Kenkyu Hokoku, 14: 183-93(Dec. 1965). (In Japanese).

Concentrations of various radioactive elements were determined before and after a visit of United States nuclear-powered submarines in the harbors of Sasebo and Yokosuka; no significant effect has been found at this time from the visits of these ships. (Pub. Health Abstr.)

10484 DETECTION OF $^{234}Th/^{234m}Pa$ IN SEDIMENTS FROM THE RIBBLE ESTUARY, LANCASHIRE, ENGLAND. Dutton, J. W. R. (Ministry of Agriculture, Fisheries, and Food, Lowestoft, Eng.). Nature, 211: 1395-6(Sept. 24, 1966).

Gamma spectrometric analysis of dried samples of silt and sand collected at the estuary of the Ribble River confirmed the presence of naturally occurring ^{40}K and ^{106}Ru and ^{95}Zr from the Windscale reactor effluents. All the activity concentrations were considerably less than those which could result in a significant radiation dose to people or to marine organisms. (F.S.)

10485 OBSERVED VARIATIONS IN THE STRONTIUM CONCENTRATION OF SEA WATER. Angino, Ernest E. (Univ. of Kansas, Lawrence); Billings, Gale K.; Andersen, Neil. Chem. Geol., 1: 145-53(1966).

Strontium content was determined in water samples obtained

from 5 widely separated areas of the North Atlantic Ocean, including surface and deep-water samples from both cold North Atlantic area and the warm subtropical Caribbean area. The results differ from many of the previously reported values for strontium in seawater. A table showed the Sr content of seawater estimated in 9 earlier investigations; levels varied from 6.5 to 14.4 mg/l, averaging about 8.1 mg/l. It is suggested that the more correct values for strontium in seawater is less than the commonly accepted figure of 8.0 to 8.2 mg/l and most likely lies between 7.2 and 7.8 mg/l. The use of an average figure for Sr in seawater should be discouraged since the soluble Sr content in seawater varies considerably; consequently the assumption of a constant Sr/Cl ratio in the ocean is in error. The mean Sr content was 6.50 mg/l for the North Atlantic waters and 7.50 mg/l for the Gulf and Haitian samples. If the most likely value of Sr concentration in seawater is between 7.2 and 7.8 mg/l, on the basis of the accepted 8.0 mg/l level the Sr values from the North Atlantic are low by 19% and those from the Gulf of Mexico by 7%. (BBB)

Seismology

10486 P-WAVE COUPLING OF UNDERGROUND NUCLEAR EXPLOSIONS. Springer, Donald L. (Univ. of California, Livermore). Bull. Seismol. Soc. Amer., 56: 861-76(Aug. 1966).

An analysis is made of the transmission of seismic energy through various detonation media as influencing interpretation of seismic signals from underground nuclear explosions. P-wave amplitude data for underground nuclear explosions are correlated with detonation energy. Amplitudes are reproducible to 25% when source media and propagation path differences are minimized. These data verify theoretical scaling relations and establish relative coupling for various shot media. An empirical correlation of these amplitude data with dry porosity of the detonation medium indicated that a medium with 60% dry porosity may couple explosive energy one-fourth or one-fifth as efficiently as does alluvium. The relation of teleseismic magnitude to explosive yield for various types of low coupling showed that dry porous media give a significant reduction of seismic signals generated by underground nuclear explosions. Inspection of teleseismic magnitude-yield curves, with an assumption of the magnitude thresholds for detection and/or identification of earthquakes and underground explosions, will automatically give yield thresholds for underground nuclear device testing. For instance, a detection threshold of magnitude 4 gives 10 Kt as the min yield detectable for alluvium coupling. The min yield detectable for dry ashfall or wet diatomite type coupling is estimated to be 50 Kt. The full decoupling curve (for salt) is shown for comparison. (BBB)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 10460, 10463, and 10969.

10487 (AD–636440) DEBRIS DISTRIBUTION. Final Research Report. Feinstein, D. I. (IIT Research Inst., Chicago, Ill.). Mar. 1966. Contract OCD-PS-64-50. 118p. (IITRI–M6066). CFSTI $3.00 cy, $0.65 mn.

A continuation of the "Debris Clearance Study" is reported. That study developed methods of estimating gross debris accumulation in various types of urban areas, based on total structural demolition and uniform distribution of the debris over a given size area. The present study makes use of several of the tools developed in the previous report and expanded herein to more accurately predict the debris distribution. Structural fragmentation is defined for a particular set of blast and structural parameters. The trajectories of the transportable material are calculated, and the distribution of this material is found by size as well as mass. In order to establish the credibility of the fragmentation theories which were developed, a series of experiments were conducted on brittle beams under dynamic loading. A sample problem is worked out that utilizes the above techniques on a hypothetical building to illustrate how the building's debris distribution may appear under various conditions of building height and fragment size distribution. (TAB)

10488 (AWRE-Lib-BIB/14) LIST OF UNCLASSIFIED PUBLICATIONS AND AWRE REPORTS BY STAFF OF THE WEAPONS GROUP PUBLISHED DURING THE YEAR 1965. (Atomic Weapons Research Establishment, Aldermaston (England)). Apr. 1966. 41p. Dep. mn.

153 references to reports and publications issued in 1965 in the fields of biology and medicine, chemistry, engineering, health and safety, instrumentation, metallurgy, and physics by the staff of the Weapons Group, UKAEA Atomic Weapons Research Establishment are presented. References are arranged alphabetically by author in the subject categories. Definitions of the subject categories are given. An author index is included. A list of errors and omissions for previous lists is appended. (F.S.)

10489 (RM–5203-TAB) NUCLEAR WAR AND SOIL EROSION: SOME PROBLEMS AND PROSPECTS. Katz, Y. H. (RAND Corp., Santa Monica, Calif.). Dec. 1966. Contract AT(04-3)-414. 93p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An exploratory survey is reported on the implications of thermonuclear war on the problem of soil erosion in a postattack environment. The current problem of soil erosion is reviewed. For the postattack period the most serious problem would be damage to the ground cover by the attack, subsequent fires and radiation damage, and the diminishment of human efforts to combat erosion because of land desertion, or where insufficient effort can be mobilized to carry through major erosion-combatting projects. (F.S.)

10490 (UCID–5033) SOC: A NUMERICAL MODEL FOR THE BEHAVIOR OF MATERIALS EXPOSED TO INTENSE IMPULSIVE STRESSES. Seidl, F. G. P. (California Univ., Livermore. Lawrence Radiation Lab.). July 9, 1965. Contract W-7405-eng-48. 191p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A Lagrangian computer code known as SOC is described. This code is used to predict the reactions of media to impulsive forces; it was designed primarily to calculate the results of underground nuclear explosions. Some aspects of the code have been verified experimentally; namely, the hydrodynamic and the elastic modes of material response. Although restricted to one dimension, e.g., plane, cylindrical, or spherical symmetry, SOC can be used to model more modes of solid behavior than any other known code. Beside being able to treat free-running shocks by means of the von Neumann-Richtmyer artificial viscosity, the program includes: compressible flow, shock vaporization, shock melting, crushing, compaction, repeated opening and closing of cracks in one or two principal directions or both, combined plastic-elastic behavior, elastic behavior, and chemical detonations. In addition, the tests for plastic flow and crushing can depend upon rate of strain. Experimental confirmation of some of the above specified SOC-model processes for rock materials is not available. The necessary physics understanding and experimental inputs are in some cases not well known. Driving forces are introduced by an idealization of the violent expansion of a localized region of extremely hot gas, from a prescribed pressure-profile, and through numerically simulating detonation of a chemical explosive. Two types of output are available: periodic printouts of the variables of active zones, and plots of variables as a function of time at 25 material points. Consideration is also given to the basis for employing an artificial viscosity. The question of computational stability is examined in some detail. (auth)

10491 (UCID–5137) NUCLEAR PROLIFERATION. A Selective, Annotated Bibliography, 1960 to 1965. Felo, Mary (comp.) (California Univ., Livermore. Lawrence Radiation Lab.). May 31, 1966. Contract W-7405-eng-48. 76p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

123 annotated references to unclassified publications issued for the most part between 1960 and 1965 on nuclear proliferation are presented. References are arranged in the following general subject areas: prospect of nations' acquiring nuclear capabilities; national policies of various countries toward acquisition of nuclear weapons; argument for encouraging or combating proliferation; and suggested measures for dealing with the spread of nuclear weapons. (F.S.)

10492 (UCRL–14711) STATIC PV CURVES OF CRACKED AND CONSOLIDATED EARTH MATERIALS TO 40 KILOBARS. Stephens, D. R.; Lilley, E. M. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 28, 1966. Contract W-7405-eng-48. 68p. (CONF-660451–1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Conference on Shock Metamorphism of Natural Materials, Greenbelt, Md.

The hydrodynamic codes used to calculate the effects of underground explosions for the Plowshare Program require the equations of state of the rock in which the explosion takes place. The PV curves of the rock to 40 kilobars at 25°C were measured. Since the PV curve of the rock changes when the rock is cracked by the shock, a method was developed to obtain the corresponding values for the cracked material. The basic equipment and technique for data on consolidated materials are the same as those described by P. W. Bridgman and by G. C. Kennedy. The specimen is cracked by pressurizing it in a piston-cylinder die with a faulty piston until the piston breaks. The sudden release of pressure when the piston fails breaks the sample by tensile fracture. The broken piston is removed from the die; a new piston is inserted, and data are taken with the cracked specimen. The "cracked" and "consolidated" equations of state for materials of interest to Plowshare ranging from sand to single crystals have been obtained. For the loading curve (increasing pressure) there are essentially two types of behavior. Cracking a porous material allows it to compress to a smaller volume (at constant pressure) than the solid. Cracking apparently is effective in breaking the ridigity of the porous compact so that it will compact more efficiently. In contrast, cracking a dense rock produces a larger volume at equal pressure. At a sufficiently high pressure, the consolidated and the cracked curves become identical. This sort of behavior is related to the porosity induced by cracking and to the porosity of the consolidated rock. Using the model developed by Walsh for the effect of crack porosity on compressibility, the qualitative features of the PV curves are accounted for. (auth)

10493 (UCRL–50008-66-2) PLOWSHARE PROGRAM, VOL. II, NO. 3. Quarterly Report No. 7, July 15, 1966–October 31, 1966. Rabb, David D. (comp.) (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 31, 1966. Contract W-7405-eng-48. 35p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Studies of the physics of cratering excavations have continued, and the data used to calculate the Cabriolet event. Economic studies were made, and details of plans for the underground uses of nuclear explosions were developed. These applications include copper leaching in Project Sloop, oil shale retorting in Project Bronco, terminal natural gas storage in Project Ketch, and gas reservoir stimulation in Project Gasbuggy. Another Plowshare detonation in the series of experiments directed toward the development of nuclear excavation explosives which minimize the release of radioactivity has been conducted successfully. Advances were made in experimental and theoretical studies connected with shock position measurement, gravimetric density determination, free-field particle motions, diagnostic techniques, and the tritium problem connected with Gasbuggy. (L.C.L.)

10494 (UCRL–50133) WEAPON EFFECTS DISPLAY SYSTEM. Fried, Morton J. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 10, 1966. Contract W-7405-eng-48. 15p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The Weapon Effects Display System (WEDS) concepts of displaying weapon effects has been successfully developed. It bridges the gap between the nuclear weapon user and the complexities of scientific data. The user can readily visualize and rapidly evaluate

many tactical situations and collateral damage trade-offs. Weapon effects parameters and their interrelationships can be directly portrayed and optimized applications rapidly determined. Although the system now developed is a nonspecific general purpose machine, it has shown that special purpose systems of a much simpler design can be built to meet the users' specific requirements. (auth)

10495 (JPRS-38744) CONDITIONS OF THE FORMATION OF PARTICLES OF RADIOACTIVE FALLOUT AND FRACTIONING OF ISOTOPES IN AN UNDERGROUND NUCLEAR BURST WITH THE ESCAPE OF GASES FROM THE GROUND. Izrael, Yu. A. Translated from Dokl. Akad. Nauk SSSR, 169: 573-6 (1966). 6p. (TT-66-35168). CFSTI $3.00 cy, $0.65 mn.

The formation of radioactive particles, including their isotopic composition, in an underground nuclear explosion in which gas is discharged from the ground, is compared to ground and atmospheric explosions. Calculations indicated that in a cavity the high temperatures produced by an underground explosion, with gas discharge from the ground, is maintained for a prolonged period of time. The temperature of about 1500°C equals the melting point of the ground. This produces weak fractionation of radioactive products. The most highly pulverized fragments are in the upper part of the cloud; finer fractions may be expected in the short range trail and minimum fractions in the crater zone, where fallout occurs from a zone that has retained a high temperature for a long time. (F.S.)

10496 SOME ASPECTS OF THE APPLICATION OF NUCLEAR ENERGY TO LARGE CIVIL ENGINEERING PROJECTS. Keller, Anton (Gruner Freres, Basel). Trav. Publics Entrep., No. 54, 5-14(1965). (In French).

A summary is given of the important factors in the application of nuclear energy to civil engineering projects, particularly excavation projects. A general description is given of the technique of nuclear excavation. The radioactivity produced in nuclear excavations, its distribution, and the means of controlling it are indicated. (J.S.R.)

10497 SURFACE DISPLACEMENTS DUE TO AN UNDERGROUND EXPLOSION. Bycroft, G. N. (Stanford Research Inst., Menlo Park, Calif.). Bull. Seismol. Soc. Amer., 56: 877-88 (Aug. 1966).

The problem of estimating surface displacements of the earth due to underground explosions, particularly in the case of detection of nuclear testing, is considered. The earth is not a linearly elastic half-space and close to the source of the explosion many phenomena take place, but outside some particular spherical surface centered at the origin of the explosion an elastic description of the wave propagation provides a first approximation. The simple solution to the problem of the surface displacements on an elastic half-space which is presented is based on derivation of the transient case for a point source from the steady state point source and then proceeding to the case of a finite spherical cavity by means of a retarded potential. Theoretical values of maximum displacement compared favorably with measured values from the underground test shot Rainier, a nuclear explosion of Operation Plumbbob. The analysis which is shown gives explicit solutions to the surface displacements when a Heaviside jump in velocity is imposed on a sphere of zero radius. Simple convolution formulas allow these results to be extended to the case of a velocity of arbitrary shape imposed on a spherical cavity of finite radius up to the time when waves are reflected back from the spherical cavity to any point on the surface in question. Computed values of the maximum vertical displacements measured during an underground nuclear test compared favorably with the theoretical values. (BBB)

Facilities and Equipment

Refer also to abstracts 10536, 10577, 10579, 10580, 10584, 10593, 10597, 11579, 11580, and 11583.

10498 (AECL-2828) AN IMPROVED METHOD OF SUPPORTING THE STATIONARY RING OF A FACE-TYPE ROTATING SHAFT SEAL FOR HIGH PRESSURE WATER SERVICE. Watson, R. D. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Feb. 1964. Reprinted Dec. 1966. 12p. (CRE-1202). Dep. mn. AECL $0.50.

Tests were conducted to determine the best method of supporting the stationary ring of a face-type rotating shaft seal for high pressure water service. The difference in seal operating characteristics was determined using identical test conditions but different supporting materials for the stationary ring. The leak rate was measured over a range of pump speeds from 700 to 1900 rpm at pressures of 400, 600, 800, and 1000 psig for each different support. The support materials were water, stacked rubber, stacked rubber rings with oil between, and cast silicone rubber. The results showed that with the stationary rings supported by a cushion of water, the leakage rate was the lowest, and that cast silicon rubber support pads act most nearly like the fluid support. (L.C.L.)

10499 (EUR-3173.e) IMPROVED METHOD OF QUANTITATIVE AUTORADIOGRAPHY FOR INDUSTRIAL PURPOSES. Matteoli, L.; Logi, P. (Istituto di Ricerche Breda S.p.A., Milan (Italy)). Sept. 20, 1966. 64p. Dep. mn.

A simple method to get quantitative measurements from autoradiographs was developed. A method has been set up that requires the exposure at the same time and with the same photographic emulsion of standards of radioactivity and of the sample under examination, tagged with the radioactive tracer. On the autoradiographs obtained, the blackening produced by the beta radiation exposure is measured by a microphotometer. By comparison of the photographic densities of the standard and the sample autoradiographs, taking into account the correction factors, a correlation is calculated, at first between photographic density and radioactivity of the tracer, then between photographic density and the concentration of the tagged constituent in the sample. Series of radioactivity standards have been prepared for ten beta-emitting radioisotopes; the relative photographic efficiency has been determined, so as radioactivity standards of radioisotopes differing from those under examination could be used. Working conditions for reproducible exposures and developments have been determined; several photographic emulsions have been tested. A method to make thin sections of metals and minerals specimens has been developed. Quantitative autoradiography was used in five studies, that are reported as examples of possible applications. They refer to the examination of components liquation in alloys, to the tagging of a mineral, to the absorption on steel surface of a corrosion inhibitor. (auth)

10500 (HW-74976) USER'S MANUAL FOR THE IBM 7090 DIGITAL COMPUTER PIPING FLEXIBILITY ANALYSIS PROGRAM. Mollerus, F. J. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 21, 1962. Contract AT-(45-1)-1350. 44p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A Piping Flexibility Analysis Program was written in FORTRAN language for an IBM 7090 computer and is capable of computing reactions and stresses in three-dimensional piping systems involving branches and loops, but it will not handle intermediate restraints. The program will handle geometries consisting of tangents and bends parallel or skewed to the axis of the coordinate system. It may consist of one branch and two anchors or complex arrangements of many branches, loops and anchors. (F.S.)

10501 (K-D-1920) STANDARD SHIPPING CONTAINER FOR 30-INCH-DIAMETER UF_6 CYLINDERS. (Oak Ridge Gaseous Diffusion Plant, Tenn.). July 20, 1966. Contract W-7405-eng-26. 34p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Two standard shipping containers for UF_6 cylinders 30 in. in dia and 81 in. long were designed and tested. One is a horizontal loading unit comprising symmetrical separative top and bottom sections, the other is an end loading unit. A phenolic high-temperature foam plastic with fiberglass additive is used as a structural and fire resistant material between the inner and outer casings. Shipping can be made with cylinders positioned at right angles to the longitudinal axis. (F.S.)

10502 (MND-3062-22) QUEHANNA PILOT PLANT FIRST GENERATION PROCESS OPERATIONS. Cochran, J.; Pierson, G. (Martin Co., Baltimore, Md.). May 1965. Contract AT(30-1)-3062. 54p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Parametric studies of strontium-90 titanate and the modification of the facilities for handling it are discussed. The Quehanna Radioisotope Pilot Plant received its first shipment of Sr-90 CO_3 in June 1962 and began processing operations in July of the same year. Processing was continued on an intermittent basis until March 15, 1964, when the process was shut down for replacement by improved, second-generation equipment. During the life of the original equipment, over a million curies of strontium-90 were processed; SNAP 7B and SNAP 7F thermoelectric generators were loaded at Quehanna with approximately ¼ million curies each; the balance of the material was placed in underwater storage for inventory. Many improvements were made in equipment design and material for greater versatility, dependability, and operating efficiency; and all the foregoing was accomplished without radiation-associated injury. The experience gained through actual operation has been utilized in the design and installation of the new process now ready for further production of varied strontium compounds. These compounds will be made with greater efficiency and safety as the direct result of the work which is described. (auth)

10503 (NAA-SR-12233) MERCURY RANKINE PROGRAM BOILER DEVELOPMENT SUMMARY. Baumeister, E. B. (Atomics International, Canoga Park, Calif.). Jan. 15, 1967.

Contract AT(11-1)-Gen-8. 65p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The Mercury-Rankine Program NaK-to-mercury boiler development program history and present status are presented. Also included are the results of boiler conditioning studies, thermal-hydraulic boiler design procedures, and advanced application conceptual designs. (auth)

10504 (NP-16382) EVALUATION OF POTENTIAL USES FOR RADIATION PROCESSING IN LOUISIANA INDUSTRIES. Killgore, C. A.; McKee, A. G. (Louisiana Polytechnic Inst., Ruston. Nuclear Center). June 29, 1966. 70p. Board of Nuclear Energy, State Capitol, Baton Rouge, La.

For Louisiana Board of Nuclear Energy, Baton Rouge.

Industrial applications of radioisotopes and radiation in Louisiana industries are discussed. Sources of radiation are reviewed. Radioisotope applications in gaging, radiography, SNAP-devices, and tracer studies are summarized. Radiation processing in chemical synthesis and manufacturing and in the preservation of food and food products are reviewed. (F.S.)

10505 (NP-16505) SPACE PROGRAMS SUMMARY 37-41. VOL. IV. SUPPORTING RESEARCH AND ADVANCED DEVELOPMENT FOR THE PERIOD AUGUST 1 TO SEPTEMBER 30, 1966. (Jet Propulsion Lab., Pasadena, Calif.). Oct. 31, 1966. Contract NAS 7-100. 298p.

Progress is reported on the JPL space exploration programs and related supporting research and advanced development projects. The following projects are discussed: systems analysis; engineering; guidance and control; engineering mechanics; environmental simulation; propulsion; space sciences; telecommunications; and advanced studies. (R.C.K.)

10506 (NYO-3237-7) EXPERIMENTAL TEST AND EVALUATION OF A GAS-BEARING BRAYTON CYCLE TURBOCOMPRESSOR. Progress Report, June 20 to September 1, 1966. Meacher, J. S. (Mechanical Technology Inc., Latham, N. Y.). Dec. 15, 1966. Contract AT(30-1)-3237. 262p. (MTI-66TR45). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Feasibility of, and problem areas associated with, the application of gas-lubricated bearings to closed-system gas-turbine machinery are discussed. A Brayton cycle gas generator (turbocompressor) utilizing self-acting gas bearings was designed, built, and is being tested. Self-sustained closed-loop operation of the turbocompressor, using its own cycle gas as the bearing lubricant, was achieved. The turbocompressor has been successfully operated, with nitrogen at 1300°F (design point) and 1400°F (design maximum) turbine inlet temperature and at a speed of 24,000 rpm. The turbocompressor has also been operated under "no-load" and "load" conditions in argon at turbine inlet temperatures up to 1355°F. Tests were made to determine the dynamic response of the turbocompressor-loop system to transients in loop pressure level, compressor bleed flow, and throttle valve setting. Plots of response data are presented for these transient tests and for heater power and compressor inlet temperature transient tests. A number of steady-state test points were taken with the turbocompressor operating at 30 psia compressor inlet pressure (the design value is 15 psia). Additional turbocompressor performance test data were secured using argon for the loop working fluid and bearing lubricant gas. The maximum average turbine inlet temperature during these argon runs was 1355°F. A new hydrostatic-hydrodynamic thrust bearing has been designed, fabricated, and installed on the turbocompressor. (F.S.)

10507 (ORNL-P-2741) THE NATIONAL CRITICALITY DATA CENTER. Johnson, E. B. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 10p. (CONF-661206-2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Nuclear Society, National Topical Meeting, Nuclear Criticality Safety, Las Vegas, Nev.

A Criticality Data Center has been established at the Oak Ridge National Laboratory under the sponsorship of the USAEC for the purpose of collecting from sources, both in the United States and abroad, information applicable to criticality safety problems. The principal output of the Center is typified by TID-7028, "Critical Dimensions of Systems Containing ^{235}U, ^{239}Pu, and ^{233}U," and TID-7016, "Nuclear Safety Guide," both of which were originally the results of group efforts not under the sponsorship of the Center. The former document summarizes most of the data available at the time of its publication and will require frequent expansion. The latter document is presently under revision to incorporate the results of more recent measurements and to reflect the development of reliable theoretical analysis. Both documents are internationally known and used. (auth)

10508 (RT-EL-(66)3) STUDIO DELL'ANDAMENTO DEL GRADO DI SICUREZZA IN FUNZIONE DEL COSTO PER UN COMPLESSO ELETTRONICO DI CONTROLLO MEDIANTE APPLICAZIONE DELLA PROGRAMMAZIONE DINAMICA. (Study of the Failure Rate as a Function of Cost for an Electronic Control Complex Using Dynamic Programming). Carlucci, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 19p. (In Italian). Dep. mn.

The failure rate versus cost optimal sequences of electronic control equipment is determined. A comparison is made among the solutions obtained for improving components reliability and applying redundant techniques in the presence or absence of preventive maintenance. (auth)

10509 (SC-TM-66-2614) A COMPARISON AND EVALUATION OF THE HELIUM PRESSURIZATION AND RADIFLO METHODS OF LEAK RATE DETERMINATION. Ford, L. M. (Sandia Corp., Albuquerque, N. Mex.). Dec. 1966. Contract AT(29-1)-789. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The general theory, calculations, advantages, and disadvantages of the helium pressurization and Radiflo methods of leak rate determinations are discussed. (auth)

10510 (SWRI-1228P8-32) FUNDAMENTAL INVESTIGATION OF LIQUID-METAL LUBRICATED JOURNAL BEARINGS. Topical Report No. 2. Burton, R. A.; Hsu, Y. C. (Southwest Research Inst., San Antonio, Tex.). Jan. 12, 1967. Contract AT(11-1)-1228. 88p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

By reference to new experimental data and by numerical calculations which exploit and extend the applicability of one of the more promising techniques, the behavior of crossed Couette and pressure flows can be predicted with good accuracy. Experimental results showed large pressure changes near discontinuities in the bearing surfaces such as found in stepped pads and in spiral-groove bearings. Generalizing the pressure rise data for the entry region of pads, this effect as a boundary condition in computations of the performance of tilted pads was discussed. In view of the foregoing critical discussions, it seems that the calculated performance is realistic. The fact that pad-tipping is predicted by these calculations, under some circumstances, should serve as a warning to designers. The negative pressure observed in stepped pads and spiral-groove configurations indicates conditions under which films would be expected to cavitate. Since this may also lead to malfunction of the bearing or seal, such observations are expected to lead, ultimately, to statements of design limitations. They also serve to provide explanations of previously observed film-breakup in such configurations as the screw-thread seal, a topic which has been the subject of considerable speculation and mystery. (auth)

10511 (TID-4100(Suppl.36)) SUPPLEMENTAL INSERT SHEETS FOR ENGINEERING MATERIALS LIST. Sachs, Francis L. (ed.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Dec. 1966. 82p. Dep. DTI Extension Free.

Twenty-eight packages of engineering materials on hot laboratory equipment, electronic instruments, engineering equipment, metallurgical equipment, radiation detectors, equipment used with particle accelerators, biological research equipment, reactors, and measuring projectors are announced in this supplement for inclusion in TID-4500. (F.S.)

10512 (UCRL-11200(Vol.2)(Rev.)) INDEX OF LRL BERKELEY MECHANICAL ENGINEERING DEPARTMENT ENGINEERING NOTES AND SPECIFICATIONS. VOLUME 2, REVISED SEPTEMBER 1966. Turner, James O. (California Univ., Berkeley. Lawrence Radiation Lab.). Contract W-7405-eng-48. 273p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Supersedes April 1965 Issue of Volume 2.

Engineering notes and specifications issued by the Mechanical Engineering Department of the Lawrence Radiation Laboratory at Berkeley from March 15, 1963 to June 1966 are listed and indexed. The documents are indexed by category codes which are used to collect documents according to project, program, or general field of interest and by a Keyword-Plus-Title index which is an alphabetical listing by key words or by the subject matter of the contents. (F.S.)

10513 (UCRL-16574) FILTRATION STUDIES WITH ULTRAFINE PARTICLES. Bhagat, Ashok Kumar; Wilke, Charles R. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1966. Contract W-7405-eng-48. 110p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

A new continuous filter was developed to filter very fine particles of about 1 to 6 micron size without cake formation. The slurry is filtered through a rotating filter membrane and solids are rejected as a thick slurry. A general theory was also developed to predict the limiting filtration rate for such a filter. This theory considers the centrifugal force on the particles and their diffusion in a highly turbulent field ($6 \times 10^5 < Re_D < 11 \times 10^5$).

Shear stress on the membrane and the drag coefficients were also measured and compared with the available data in the literature. Limiting filtration rates up to 33×10^{-3} ml/sec/cm^2 were obtained for the systems considered. Agreement of the correlation with experimental data for 1.3 micron polystyrene latex spheres and 6 to 14 micron styrene divinylbenzene copolymer latex spheres is within 35%. (auth)

10514 (USNRDL-TR-1090) ANALYSIS OF DEBRIS FROM APG-3, THE SIMULATED DESTRUCT SYSTEM TEST OF A FULL-SCALE ROVER/NERVA REACTOR. O'Connor, Joseph D.; Scheidt, Ronald C.; Pascual, Juan N. (Naval Radiological Defense Lab., San Francisco, Calif.). June 24, 1966. Contract AT(49-5)-2505. 42p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Analysis of fragments from one of four jets of debris of a high-explosive destruct test of a nuclear reactor showed that the distribution of weight with particle size was bimodal, with a major peak near 4 mm and a minor peak near 0.2 mm. The distribution of activity also was found to be bimodal, with a more pronounced peak at 0.2 mm. Specific activity calculations showed that the peak centered about the 0.2 mm size range contained the debris that was the most highly enriched in uranium. Little uranium activity was noted in particles below this size. Comparison with results of other investigations showed that a small sampling effort such as was undertaken provides adequate sampling of the debris from one jet. However, variation in particle characteristics from one jet to another would require sampling all jets in a future operation. (auth)

10515 VENTILATION OF RADIOACTIVE LABORATORIES. Barrachina, M. (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid), 10: 311-22(July-Aug. 1966). (In Spanish).

Some general considerations on the ventilation of laboratories are discussed and the requirements for the ventilation of radioactive laboratories are given. The ventilation facilities of an existing radioactive laboratory are discussed in detail. The equipment and materials used for this installation are described. A summary of the specifications is given. (G.O.Y.)

10516 AUTOMATIC IRRADIATION FACILITY FOR STERILIZATION OF SURGICAL SUTURES. Muxfeld, H. (Ethicon GmbH, Glashuette, Ger.). Kerntechnik, 8: 470-2(Oct. 1966). (In German).

The construction, function and safety interlock system of a new automatically working cobalt-60 plant for sterilization of surgical sutures are described. The plant is built to house 750,000 Ci. Problems of the bactericidal effect of ionizing radiation are discussed. (auth)

10517 NUCLEAR-POWERED SURFACE EFFECT SHIPS DESIGN PROBLEMS. Montes de Oca, Rodolfo A. (Booz-Allen Applied Research Inc., Bethesda, Md.); Simpson, Harry M. J. Aircraft, 2: 136-43(Mar.-Apr. 1965).

A preliminary study of a nuclear-powered transoceanic surface effect ship (SES) (GEM) is made to evaluate its commercial feasibility. Ship specifications of operating height and speed are determined for the ocean environment, and a range of sizes is considered to define the power requirements. Power plant weight is a critical factor and state-of-the-art research is performed for suitable nuclear power plants, and different cycles are analyzed. Optimum ship size is determined through parametric studies, for a range of power plant specific weights. Vehicle characteristics are then determined and general arrangements are made for optimum sizes considering payload and operating cost factors, identifying a 6000-ton ship as a practical size. Structural design criteria are developed for the 6000-ton ship. Truss-type structure is found most suitable for minimum weight. Machinery weight estimates are made for the complete installation and development needs are identified. Commercial feasibility is evaluated over North Atlantic routes. It is concluded that construction of a nuclear-powered SES is feasibile using present technology, but its cost characteristics would be commercially marginal. Further development of the nuclear power plant will result in a competitive ship. (BBB)

10518 OVEN AND ADJUSTING AND MOUNTING DEVICE USED WITH OVEN OR CRYOSTAT (Engineering Materials). (Brookhaven National Lab., Upton, N. Y.). (CAPE-1519).

51 drawings

The apparatus is used with a neutron crystal spectrometer in experiments with polarized monoenergetic neutrons and polarized nuclei and includes an oven and a mounting and adjusting device. The mounting and adjusting device rides on the arm of the spectrometer and an oven or cryostat is mounted and controlled by the device. The sample which is mounted on a target in the cryostat or in the oven can be rotated 90° by this device to remove the sample from the monoenergetic neutron beam permitting open beam intensity to be measured. A cryostat is used to cool the sample to ultralow temperatures and the oven is used for samples at temperatures of 825 to 4°K. The oven has sample holding equipment and is provided with two Vulcan pancake heaters. It also includes a series of floating multiple reflecting radiation shields of Al to help minimize heat loss. (For details see TID-4100 Suppl 38.) (F.S.)

10519 MODULATOR DRIVER SYSTEM FOR ASTRON ACCELERATOR (Engineering Materials). (California Univ., Livermore). (CAPE-1529).

2 drawings

The driver system for the high energy electron injection system for ASTRON, a thermonuclear device, is given in functional and block diagram format. The driver system is used with the 82 modulators which use the WX4852 modulator tube. The WL8461 tube is used in the regulator and the driver uses the 4CW 50000C tube. The driver system provides a 100 pulse burst at a maximum rate of 1440 pps, with a long-term average pulse rate of 60 pps. (For details, see TID-4100, Suppl. 38.) (F.S.)

10520 IMPROVEMENTS IN AND RELATING TO HEAT EXCHANGERS. Barochi, Gabriel; Delpeyroux, Paul; Mombazet, Rene (to Commissariat a l'Energie Atomique). British Patent 1,054,001. Jan. 4, 1967. Priority date Feb. 14, 1964, France.

A modified tubular element in which fins are used for improved heat exchange is described. The tubes have improved mechanical stability during thermal cycling. The fins are set perpendicularly or at an oblique angle on the tube wall and are arranged in an even number of identical sectors around the element. Each of the fins in each sector in the region of the tip of the fin has at least one recess or aperture. Fins in each sector are inclined with respect to fins in the adjacent sector so as to form a herringbone series so that the fins are parallel to each other in each series. Trench-like grooves in the tips of each sector are rectangular in shape and the depth of the groove is at most equal to $\frac{1}{3}$ of the height of the fin. (F.S.)

10521 IMPROVEMENTS IN SEALED DOOR SYSTEMS FOR INSERTION BETWEEN TWO ENCLOSURES. Lefort, Guy; Pillereau, Jean (to Commissariat a l'Energie Atomique). British Patent 1,054,083. Jan. 4, 1967. Priority date Apr. 17, 1963, France.

A sealed door system is described which may be interposed between two enclosures such as glove boxes where it is necessary to maintain seals between the enclosures in the closed position. A door mounted in a fixed frame to slide or act as a door shutter is provided with resilient pressure means. A groove containing a sealing lining is provided. In the closed condition, the door is pressed against the lining by the resilience of the pressure mechanism. The pressure mechanism is releasable for opening the door. (F.S.)

10522 IMPROVEMENTS IN OR RELATING TO EVAPORATORS. Williamson, William Rodger (to American Machine and Foundry Co.). British Patent 1,051,622. Dec. 14, 1966. Filed Mar. 23, 1964.

A multistage modular flash distillation apparatus is described. It may be assembled into a low to moderate capacity as well as a high capacity flash distillation apparatus. Sealing between stages is simple. The apparatus consists of a series of horizontally adjoining units separated by vertical walls. Each unit has an outer wall extending forward from the vertical wall and an inner wall extending forward from the vertical wall. The inner wall defines an evaporation chamber. The inner and outer walls define a condensing chamber surrounding the evaporating chamber. (F.S.)

10523 IMPROVEMENTS IN OR RELATING TO LIQUID FILM THICKNESS MEASUREMENT. Hewitt, Geoffrey Frederick (to United Kingdom Atomic Energy Authority). British Patent 1,051,641. Dec. 14, 1966. Filed Jan. 3, 1964.

An improved method of measuring the thickness of liquid films is described. The method consists of passing a beam of excited radiation into the liquid film to excite fluorescence. At least part of the fluorescent radiation is separated from the exciting radiation. The intensity of the separated fluorescent radiation is measured. A half-silvered mirror may be employed to produce a coaxial beam of the exciting radiation with the fluorescent radiation. The chosen wave band of the fluorescent radiation may be isolated with a spectrometer and measured with a photomultiplier. An oscilloscope and camera are used to obtain a continuous recording of film thickness. (F.S.)

10524 BEAM POSITION MONITOR (Engineering Materials). (Stanford Linear Accelerator Center, Stanford Univ., Calif.). (CAPE-1503).

78 drawings.

The beam position monitor is used to determine the position of a charged atomic particle beam at any number of points along a

linear accelerator waveguide. It was designed for the Stanford Linear Accelerator. See CAPE-1401 for other drawings on the beam position monitor. (For details see TID-4100 Suppl. 38). (F.S.)

10525 MONOCHROMATOR AND SHUTTER MECHANISM FOR X-RAY DIFFRACTOMETER /Q-2887/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1464).

5 drawings.

A multiple filter mechanism was designed and fabricated for use with a Picker X-ray Diffractometer. This unit contains two fixed-thickness filters which are independently actuated by solenoids on command from the computer controller. A third solenoid actuator operates a dual filter holder containing a fixed-thickness and a variable-thickness or balance filter. In this case either one or the other of the filters is always in the x-ray beam. Attached to this filter mechanism is a monochromator housing for use with this system. It contains a gimbal mounting arrangement for the accurate multi-directional positioning of a contoured crystal in the x-ray beam. This permits the focusing of monochromatic x rays from this crystal onto the specimen under examination. (For details see TID-4100 Suppl. 38). (F.S.)

10526 SPACE POWER REACTOR (SPR-5) (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1521).

3 drawings.

Three schematics describe a space power reactor, SPR-5. The profile and cross section of the core, and the heat pipes of the heat rejection system are shown. The core is 137 cm in dia and 22 cm thick. It is moderated by BeO_2. The heat rejection system consists of a liquid metal heat exchanger and a conical radiator. Silver and lithium vapor are used in the heat exchanger. The conical radiator has an area of 400 m^2. The sides of the cone are 890 cm long and the large diameter is 1390 cm. For details see TID-4100 Suppl. 38. (F.S.)

10527 SHUTTER MECHANISM FOR X-RAY DIFFRACTOMETER /Q-2817/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1474).

5 drawings.

A multiple filter mechanism was designed and fabricated for use with a Picker X-ray Diffractometer. This unit contains five filters which are independently actuated by solenoids on command from the computer controller. All or any combination of these filters may be inserted into the x-ray beam at any time. Four of these are fixed-thickness filters mounted in removable frames for easy change-out. The fifth is a variable-thickness or balance filter. It is made in such a manner that the filter can be tilted in the x-ray beam so that the apparent thickness, as seen by the x-ray beam, is changed. Tilting is accomplished by rotating the filter in its holder. Angle of incidence with the beam is infinitely adjustable through a range of 20°. (For details see TID-4100 Suppl. 38.) (F.S.)

Heat Transfer and Fluid Flow

Refer also to abstracts 10503, 10545, 10546, 10587, 10591, 12193, and 12204.

10528 (EUR-3162.f) FLUCTUATIONS DE TEMPERATURE DANS LA PAROI CHAUFFANTE ET DANS LE LIQUIDE AU COURS DE L'EBULLITION NUCLEEE. (Temperature Fluctuations in the Heating Wall and in the Boiling Liquid During Nucleate Boiling). Bonnet, C.; Macke, E.; Morin, R.; Salomon, J. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Nov. 1966. 104p. (In French). Dep. mn.

The nucleation phenomenon in boiling is accompanied by temperature fluctuations both in the heating wall and in the boiling liquid. It was possible to directly relate the temperature transients to the bubble history. This method is claimed to give a better understanding of the mechanisms involved. Theoretical models of bubble formation are proposed which satisfactorily agree with the experimental results. Also information on microturbulence is drawn from the fluid temperature transients between the nucleation sites. (auth)

10529 (GEAP-5287) ISOKINETIC SAMPLING PROBE TECHNIQUE: APPLIED TO TWO-COMPONENT, TWO-PHASE FLOW. Schraub, F. A. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Nov. 1966. Contract AT(04-3)-189. 45p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Isokinetic sampling provides local time-average values of gas velocity, liquid velocity, void fraction, and quality in two-phase flow. The isokinetic sampling technique as applied to adiabatic, incompressible, two-component, gas-liquid flow is described. Limitations and problems in technique, typical results, and operating experience with small diameter probes (sampling diameters near 0.03 inch) are emphasized. The technique consists of experimental determination of local flow rates and impact pressure and analysis to relate these experimental results to local void fraction. Experimental procedures and problems are discussed at length. The results of different analyses are compared and a preferred data reduction procedure is recommended. (auth)

10530 (KFK-410) THERMODYNAMIK VON TROPFEN IN DAMPF-KUEHLKREISEN. (Thermodynamics of Drops in Vapor-Cooled Circuits). Sundermann, Heinz (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorbauelemente). Sept. 1966. 5p. (In German). Dep. mn.

Equilibrium equations correlating the salt concentrations in drops after evaporation under the influence of surface stress, the complete evaporation of the drops, and their stationary radius are presented. (J.S.R.)

10531 (LA-3522) FINITE DIFFERENCE METHODS OF SOLUTION OF NONLINEAR FLOW PROCESSES WITH APPLICATION TO THE BENARD PROBLEM. Fromm, Jacob E. (Los Alamos Scientific Lab., N. Mex.). Apr. 1966. Contract W-7405-eng-36. 135p. Dep. Mn. CFSTI $3.00 cy, $0.65 mn.

A general method of numerical calculation of compressible flows is outlined in which such flows are divided into irrotational and solenoidal parts. The general equations are reduced to the Boussinesq approximation for consideration of the Bénard problem. The Bénard problem, both in method of solution and result, is used to analyze a number of crucial aspects of finite difference calculation. In particular, the nonlinear formulations in current use are developed and related in a systematic way; and, in addition, some higher order methods are derived. Examples of the time-dependent behavior of the thermal convection problem are examined for physical interpretation in terms of gross property measurements and character of instantaneous solutions with the hope that the experience so gained will be valuable to extensions of the numerical method to more general problems. (auth)

10532 (LA-DC-7938) HEAT PIPE CAPABILITY EXPERIMENTS. Kemme, J. E. (Los Alamos Scientific Lab., N. Mex.). [1965]. Contract W-7405-eng-36. 10p. (CONF-661116-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Thermionic Conversion Specialist Conference, Houston, Tex.

Axial heat transfer limits were determined for several heat pipe systems to show methods for increasing heat transfer capability and to check the validity of existing heat pipe equations. Measurements were made at operating temperatures from 450 to 850°C. Sodium and potassium were used as working fluids. Two-component wicks were tested because they provide a means for increasing heat pipe performance by utilizing fine pores for fluid pumping and a less restrictive path for liquid return. Heat pipe construction and preparation techniques are described. Pertinent fluid properties are plotted as a function of temperature. Heat pipe equations are listed and the experimental results are compared with calculated heat transfer limits. (auth)

10533 (N-66-19533) TRANSIENT TWO-PHASE HEAT TRANSFER AND FLOW CHARACTERISTICS OF LIQUID HYDROGEN. Campi, F. A.; Chi, J. W. H.; De Zubay, E. A.; Holmgren, J. D.; Vetere, A. M. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Apr. 1963. 89p. (NASA-CR-71087; WANL-TNR-102). CFSTI $3.00 cy, $0.65 mn.

The initial phase of a program designed to evaluate transient two-phase heat transfer and flow characteristics of hydrogen as an integral part of the NERVA reactor requirement are summarized. A hydrogen facility and cryogenic laboratory was built, and experiments were performed to obtain the desired data. The experimental program included studies of single phase heat transfer, two-phase flow, and forced convection transient boiling heat transfer. The investigations were made with cold gaseous and liquid hydrogen flowing through horizontal test sections over a range of conditions. Cool-down temperature, cool-down time, single phase heat transfer coefficients, transient two-phase flow characteristics, and two-phase heat transfer coefficients are presented. It was shown that, in the film boiling and transitional regimes, thermodynamic equilibrium cannot exist between the vapor and the liquid. The mechanisms of two-phase flow during cool-down was discussed in detail, and a two-phase flow model has been postulated. (auth)

10534 (N-66-33710) EXPERIMENTAL INVESTIGATION OF BAFFLE EFFECTIVENESS IN A CONFINED FLUID SUBJECTED TO WALL AND NONUNIFORM SOURCE HEATING. Biesiadny, Thomas John (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Aug. 1966. 66p. (NASA-TM-X-57817). CFSTI $3.00 cy, $0.65 mn.

Thesis. Submitted to Purdue Univ., Lafayette, Ind.

Heating of liquid hydrogen in the propellant tank of a nuclear rocket was simulated in a two dimensional view tank with and without baffles present The effectiveness of the baffles in preventing the occurrence of large fluid temperature differences was determined. To accomplish this objective a mixture of trichloroethane and ethyl alcohol was used to represent the liquid hydrogen. Both wall and nonuniform source heating occur in nuclear rocket propellant tanks. In this study infrared rays from quartz lamps were used to produce the two types of heating required. The tanks were subjected to similar heating conditions with and without baffles, and visual information concerning fluid behavior was obtained using schlieren photographs. Fluid temperatures were measured using thermocouples. Quantitative comparisons were made possible by calculating a temperature nonuniformity parameter for each case. (STAR)

10535 (NASA-TN-D-3798) DIGITAL CODES FOR DESIGN AND EVALUATION OF CONVECTIVELY COOLED ROCKET NOZZLE WITH APPLICATION TO NUCLEAR-TYPE ROCKET. Rohde, John E.; Duscha, Rudolph A.; Derderian, George (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Jan. 1967. 91p. CFSTI $3.00 cy, $0.65 mn.

The design of the coolant passages of a convectively cooled nozzle is dictated by heat transfer and flow considerations that are compatible with the overall rocket system and acceptable stresses within the nozzle structure. The method presented for designing this type of nozzle utilizes both a design and an evaluation computer program used in conjunction. These digital computer programs are coded in FORTRAN IV for use on an IBM 7094 computer. The design program calculates coolant passage dimensions for a specified gas-side wall temperature distribution, and the evaluation program calculates a gas-side wall temperature distribution for specified coolant-passage dimensions. In addition, coolant conditions are calculated, and all heat transfer and fluid flow results are utilized to calculate coolant-passage tangential and longitudinal stresses. The programs are set up to utilize a range of heat transfer correlations, different tube surface roughness conditions, and a tube splice. The evaluation program has the additional capability to handle radial or flat-plate heat conduction across the tube crown and the application of a coating to the gas side of the coolant passage. Application of these programs is shown for the design and the evaluation of a nuclear-type rocket nozzle operating at chamber conditions of 4000°R and 530 psia with hydrogen as both the coolant and the propellant. The wide range of available heat transfer correlations for both the hot-gas and coolant sides and the conduction model used across the tube crown result in maximum gas-side wall temperatures ranging from 1550° to 2250°R. The majority of the calculated coolant-passage stresses are well into the plastic range for the material considered (347 stainless steel). (auth)

10536 (NEL-160) EXPERIMENTAL CONDENSER FOR HEAT-TRANSFER MEASUREMENTS. Osment, B. D. J.; Speirs, R. R. M.; Rugman, W. (National Engineering Lab., Glasgow (Scotland)). Aug. 1964. 34p. Dep. mn.

Most former investigations of condensation have concerned single tubes and small flat surfaces. To provide data for direct use in condenser design a study has been made of heat transfer with condensation of steam in practical conditions. An experimental condenser and its auxiliary equipment, used to study condensation of sub-atmospheric steam on conventional tube bundles, is described. A program of heat transfer measurements with filmwise condensation of steam, and details of the test procedure, are outlined. Tables of experimental results for the complete bundle and for individual tubes in the bundle are given. (auth)

10537 (NYO-2930-9) SOME STATISTICAL TURBULENCE PROPERTIES OF THE FLUID PHASE IN A GAS SOLID SUSPENSION. Technical Report No. 112-ME-F. Peskin, Richard L.; Wallace, John P. (Rutgers-The State Univ., New Brunswick, N. J. Dept. of Mechanical and Aerospace Engineering). Sept. 1966. Contract AT(30-1)-2930. 126p. Dep. mn. CFSTI $4.00 cy, $0.75 mn.

The longitudinal intensity of turbulence and the longitudinal spectra of the suspension fluid were measured by means of a glow discharge probe in a 3″ square duct. For a mean velocity of 85 FPS and a solids loading ratio of .465 pounds of .0058″ dia glass beads per pound of air, the intensity at the center of the duct is shown to decrease. Upon introduction of the particles the spectra of the fluid shows a modulation effect in which the energy density at low frequencies is decreased and the energy density at high frequencies is increased. An analysis of the high wavenumber regime using the Pao transfer function and assuming that the particles produce a uniformly distributed volume force described by the Stokes drag predicts the behavior of the measured spectra. (auth)

10538 (SAN-650-3) ORGANIC RANKINE CYCLE FEASIBILITY DEMONSTRATION PROGRAM. Third Quarterly Report, September 30-December 31, 1966. Publication No. U-3910. (Aeronutronic Div., Philco Corp., Newport Beach, Calif.). Jan. 10, 1967. Contract AT(04-3)-650. 115p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An investigation of the technology necessary to successfully develop an organic Rankine cycle power conversion system capable of long duration in a space environment is described. The specific organic working fluid to be evaluated is monoisopropylbiphenyl (MIPB). The initial program consists of four tasks: fluid properties evaluation, bearing development, boiler development, and power system design study. The objective of the fluid properties evaluation task is the macroscopic engineering evaluation of the working fluid MIPB. For this purpose, three simulated power conversion loops will be operated for a duration up to 5000 hours. The test loops have been sized to correspond to the operating conditions of 1.5 kw_e power conversion system having a boiler exit temperature of 650°F and a condenser pressure of 1 psia. Each test loop consists of a forced circulation boiler with separator, regenerator, condenser, turbine-motor driven multipumps, controls, and instrumentation. The test loops are being designed for hermetic, unmonitored and continuous operation. The objective of the bearing development task is the analytical and experimental evaluation of sleeve-type and rolling contact journal and thrust bearings. Beside screening of various bearing systems, lubricity of the working fluid and other properties such as viscosity, and surface-tension, will be measured. The boiler development task consists of a parametric design study of recirculation boilers for the 1 to 10 kw_e range and an experimental study of the effects of boiler inlet velocity, film drop, surface temperature and exit quality on heat transfer surface fouling. Finally, the design study of a complete space power unit will be performed using test data of the experimental portion of this program. (R.C.K.)

10539 (TID-23503) A STUDY OF THE OPERATING CHARACTERISTICS OF THE HEAT PIPE. Fifth Quarterly Progress Report. Ferrell, J. K.; Carnesale, A. (North Carolina State Univ., Raleigh). Oct. 1, 1966. Contract AT(40-1)-3411. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A stainless steel heat pipe was designed to obtain an understanding of the mechanisms involved in the operation of a heat pipe, to predict the operational characteristics, and to establish a procedure for the engineering design of heat pipes. Experiments were carried out with stainless steel beads to determine void fraction, permeability, and capillary rise height for various ranges of bead size. These characteristics are relevant to heat pipe operation. (F.S.)

10540 (WAPD-TM-568) WATER: A LARGE RANGE THERMODYNAMIC AND TRANSPORT WATER PROPERTY FORTRAN-IV COMPUTER PROGRAM. Coffman, W. A.; Lynn, L. L. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Dec. 1966. Contract AT(11-1)-Gen-14. 75p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

WATER is a FORTRAN-IV digital computer subroutine used to extract thermodynamic and transport properties of liquid, vapor, and supercritical water by tabular interpolation over the range of states: 14.5 to 14,500 psia, and 32 to 1472°F. Bi-linear interpolation is used with provision to extrapolate to states outside table limits. The principal source of data is the skeleton tables adopted by the Sixth International Conference on the Properties of Steam. Continuous approximations of pressure and temperature partial derivatives are provided. An independent representation is given for saturated liquid and vapor properties. (auth)

10541 APPLICATION OF THE FINITE ELEMENT METHOD TO HEAT CONDUCTION ANALYSIS. Wilson, Edward L.; Nickell, Robert E. (Univ. of California, Berkeley). Nucl. Eng. Design, 4: 276-86(Oct. 1966).

A variational principle is applied to the transient heat conduction analysis of complex solids of arbitrary shape with temperature and heat flux boundary conditions. The finite element discretization technique is used to reduce the continuous spatial solution into a finite number of time-dependent unknowns. The continuum is divided into subregions (elements) in which the temperature field variable is approximated by Rayleigh-Ritz polynomial expansions in terms of the values of the temperatures at prescribed boundary points of the subregions. These temperatures at the node points act as generalized coordinates of the system and, being common to adjacent subregions, enable appropriate continuity requirements to be satisfied over the entire continuum. The variational principle yields Euler equations of the Lagrangian form which result in the development of an equivalent set of first order, ordinary differential equations in terms of the nodal temperatures. A unique method of numerical solution of these equations is introduced which is stable and requires a minimum of computer effort. Elements of various shapes and their

associated temperature fields are discussed for one, two and three-dimensional bodies. The method is developed in detail for two-dimensional bodies which are idealized by systems of triangular elements. The development of a digital computer program is discussed and several examples are given to illustrate the validity and practicality of the method. (auth)

10542 HEAT TRANSFER TO LIQUID METALS FLOWING TURBULENTLY IN ECCENTRIC ANNULI. II. Yu, W. S.; Dwyer, O. E. (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 27: 1-9(Jan. 1967).

An analytical study was carried out to determine the effects of eccentricity on both local and average heat-transfer coefficients for turbulent flow of liquid metals through eccentric annuli. The study was based on the conditions of (1) heat transfer from the inner wall only, (2) heat flux, at a given circumferential angle, independent of length, (3) inner-wall temperature, at a given axial position, independent of circumferential angle, and (4) fully developed velocity and temperature profiles. This study is a sequel to an earlier one, which described a similar case, except that the heat flux in that case was uniform in all directions. The scopes of the two studies were identical, as far as parameter ranges are concerned. In general, the effects of eccentricity were found to be much less in the present case. For a given radius ratio r_2/r_1, and a given eccentricity, the circumferential variation of the local heat-transfer coefficient and the reduction in the average heat-transfer coefficient were both much less. Moreover, the reduction in the average heat-transfer coefficient, caused by a given degree of eccentricity, was found to be only slightly dependent on the radius ratio, in the present study. This is also in sharp contrast with the results of the previous study. It was further found that circumferential variation of the normalized local heat flux $q/\bar{q}$, and, therefore, that of the normalized local heat-transfer coefficient also, remained the same over the large range of Peclet numbers investigated, for a given radius ratio and a given degree of eccentricity. (auth)

10543 LAMINAR HEAT TRANSFER IN A HEXAGONAL CHANNEL WITH INTERNAL HEAT GENERATION AND UNEQUALLY HEATED SIDES. Hsu, Chia-jung (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 26: 305-18(Nov. 1966).

The heat transfer characteristics for the case of laminar flow through a hexagonal channel have been determined for the following conditions: The uniform heat flux on any one side of the hexagon is identical to that on the opposite side, and may be equal to or different than those on the two adjacent sides; both the velocity and temperature profiles are fully established; the heat transfer from the walls may or may not be accompanied by simultaneous internal heat generation in the flowing fluid. Fundamental temperature solution and equations are presented which may be used to predict the temperature field, or to calculate the difference between local wall temperature and the bulk fluid temperature for a variety of cases. Methods of predicting the variation of local wall temperature are illustrated for several typical cases, including the case of uniformly distributed wall heat flux. For the latter case, it was found that appreciable temperature variation exists along the periphery of the hexagon. The circumferential variation of the local Nusselt number and the mean Nusselt number are also reported, with and without internal heat generation. (auth)

Isotope Technology

Refer also to abstracts 10499, 10502, and 10618.

10544 (BNL-986) REPORT ON THE MARK II BNL STANDARD COBALT RADIATION SOURCE, BONDED TYPE. Kuhl, O. A.; Oltmann, A.; Wagner, J. (Brookhaven National Lab., Upton, N. Y.). Apr. 1966. Contract AT(30-2)-Gen-16. 26p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A brief history of radiation source development at BNL and a discussion of source design factors preface a description of the latest design of the BNL standard cobalt radiation source. This is identified as the BNL Mark II bonded-type source. Specifications, a description of methods for testing for compliance with the specifications, and the results of these tests are included. (auth)

10545 (MND-3607-89) SNAP 19 CAPSULE LOW REYNOLDS NUMBER FORCE TEST. Stouffer, C. G. (Martin Co., Baltimore, Md.). Oct. 1966. Contract AT(30-1)-3607. 62p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Low Reynolds number hypersonic force tests have been conducted on 12.27% scale models of a SNAP 19 fuel capsule and 0.668% scale models of a Nimbus B satellite solar panel. These tests were run at $M_\infty = 9.37$ in the Low Density Hypersonic Tunnel (Tunnel L) at Arnold Engineering Development Center, Tennessee. The Reynolds number, based on the model length, was 1200 for the capsule and 1024 for the solar panel. The objectives of the test were to determine the aerodynamic viscous effects on the capsule and solar panel forces and stability. Normal force, axial force, and and pitching moment were measured on each configuration for angles of attack from 0 to 90 degrees. The measured results are compared with calculated values, using both Newtonian impact and free molecule flow theories. Efforts to relate the measured force coefficients with theory through a transition equation were successful. Comparison of the calculated values of the capsule force coefficients with the measured results indicates that the equation can be used to predict the force coefficients at any altitude. Although the agreement of the calculated with the measured coefficients for the solar panel was not as good, the calculated values can still be used for preliminary analysis. The pitching moment coefficient about the center of gravity could not be related with theory. However, it is concluded that the measured pitching moment can be used for any altitude. It was also concluded that the effect of the notches on the face of the capsule was significant, and it was recommended that this effect should be investigated in future testing. The capsule has stable trim points at 0- and 90-degree angles of attack. The more stable trim point is at 90 degrees. (auth)

10546 (MND-3607-90) SNAP 19 CAPSULE FORCE AND STABILITY TEST CONDUCTED IN THE NASA LANGLEY 31-INCH CONTINUOUS FLOW HYPERSONIC TUNNEL AT MACH 10. Stouffer, C. G. (Martin Co., Baltimore, Md.). Dec. 1966. Contract AT(30-1)-3607. 51p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Data are presented for a Mach number equal to 10 and for Reynolds numbers, 0.758×10^6, 0.490×10^6, and 0.348×10^6, for model angles of attack from 0° to 90°. The objectives of the test were: (1) to obtain aerodynamic force and moment data in the continuum regime; and (2) to determine how the capsule pitching moment was affected by the notches in the face of the capsule. The effect of the notches in the face of the capsule was investigated from angles of attack from 35° to 90°. Shadowgraph pictures, taken at each angle of attack, were valuable in determining the effect of the notches. The results showed that, in the range tested, Reynolds number effect was negligible. The normal and axial force variation with angle of attack was similar to that predicted by application of the Newtonian theories. The magnitude of the axial force coefficient was nearly that predicted by the modified Newtonian theory. The normal force coefficient was nearly equivalent to the Newtonian values up to approximately 65° angle of attack. From 65° to 90° angle of attack, the normal force coefficient followed the modified Newtonian results. The largest variation between the measured results and theory occurred where the notch effect was significant. Here, the Newtonian theory differed from the measured results by a maximum of 12% for the normal force coefficient and 50% for the axial force coefficient. The pitching moment could not be predicted by theory. However, the variation of the pitching moment with angle of attack was similar to previous low Reynolds number results (MND-3607-89). Again, as in the low Reynolds number tests, the capsule had two stable trim points. In both test, the more stable trim point was at 90°. (auth)

10547 (MND-3607-112) SNAP 19 TEST REPORT: THERMAL PERFORMANCE OF MATERIALS AND MECHANICAL JOINTS. Shih, C. (Martin Co., Baltimore, Md.). Nov. 1966. Contract AT(30-1)-3607. 52p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A study was made of the thermal contact conductance of mechanical joints for application to Nimbus B/SNAP 19 thermal analysis, of the proper joint thermal conductance in scaled thermal models, and of the thermal and mechanical properties of ZH62A Mg alloy at 300 to 783°K. For the joint conductance study, three specimens of ZH62A Mg alloy against 2024-T5Al alloy, the same materials as those used on Nimbus B spacecraft, were fabricated. One used a hexagonal-head bolt, one a counter sunk head bolt and one a rivet as fasteners. All three specimens were of approximately the same size as the prototype. Thermal conductances were evaluated at four different temperatures ranging from 340 to 566°K for each load and environment pressure. For thermal scaling of joint thermal conductance, two more specimens of stainless steel were fabricated, one approximately the same size as those used on the Nimbus B spacecraft and the other a half-scale model. The steel specimens were tested under environmental conditions identical to those experienced by the Mg-Al specimens. Contact thermal conductances of joints, typical of those used on the Nimbus B spacecraft, were measured at various temperatures, both with and without a special grease between the surfaces of contact. The measured thermal conductances of all joints with grease-coated surfaces are higher by almost an order of magnitude than the minimum value given by General Electric specifications. One of the specimens tested showed some characteristics not common to all the rest, possibly due to inaccuracy as a result of the small temperature drop across the joint under greased conditions. Thermal scaling

of mechanical joints was proven to be quite feasible within the scope of interest to the Thermal Scale Model Program. Using thermal scaling criteria, scaling of material properties was within 11% at all temperatures tested. With respect to scaling to size, the experimental results agree with the criterion within 18%. The agreement of experimental results with criterion for scaling of a greased joint is about 23%. For thermal conductance of mechanical joints with a grease interface, a tolerance of 50% is recommended for thermal design purposes, due to uncertainties about the effects of temperature, pressure and time of exposure in vacuum on the thickness and density of the grease. During the measurement of materials properties, there was some uncertainty about the thermal conductivity and creep strength at temperatures close to the melting point. Verification tests of thermal conductivity of ZH62A were carried out. Some scattering of test results was noted around 770°K. (D.L.C.)

10548 (NP-16437) NEWSLETTER NO. 2 OF THE ISOTOPIC GENERATOR INFORMATION CENTRE. (European Nuclear Energy Agency, Paris (France). Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 1966. 32p. Dep. mn.

A review with comments on the UKAEA/ENEA Symposium on Industrial Applications for Isotopic Generators and the list of papers presented at the International Symposium on Industrial Applications for Isotopic Power Generators are presented. Also, a bibliography containing 57 references on dynamic conversion as applied to isotopic sources and a bibliography containing 37 references on recently published information on applications of radioisotopes are included. (F.S.)

10549 (TID-23398) SHIPBOARD IRRADIATOR STUDIES. Annual Report, May 15, 1965-May 14, 1966. Slavin, Joseph W.; Carver, Joseph H.; Connors, Thomas J.; Ronsivalli, Louis J. (Bureau of Commercial Fisheries, Gloucester, Mass. Technological Lab.). Dec. 1966. Contract AT(49-11)-1889. 91p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress is reported on the radiopreservation of seafoods. The most effective time to irradiate fish was found to be immediately after they are caught since the bacterial load would be extremely low at that time and the degradative processes would not have started. An engineering study was made which showed by various designs the feasibility of installing a complete irradiation system aboard a fishing boat and also indicated a good potential for its use. Accordingly, a 27,000-curie portable shipboard irradiator was designed and built to explore the advantages of irradiating fish at sea. After a series of performance tests at the Brookhaven National Laboratory and modifications, the irradiator was accepted for use. It was shipped to the Gloucester Laboratory for further testing, dosimetry work, and experimental use. Dosimetry measurements indicated that the unit was capable of delivering a dose of approximately 10,000 rads per minute. The irradiator was installed aboard the M.V. DELAWARE. One sea trial showed the irradiator to perform satisfactorily, even in weather conditions where the boat would roll up to 27°. Two simulated shipboard irradiator experiments were conducted using the 250,000-curie Marine Products Development Irradiator (MPDI), and one land-based shipboard irradiator experiment was conducted. Results of these few experiments indicated that freshly killed prerigor fish respond better toward the radiopasteurization process than do post-rigor fish — fish that had been iced 24 hours after sacrificing. One irradiation experiment at sea indicated that surf clam meats can be successfully irradiated at levels ranging from 100,000 to 450,000 rads and that their storage life is at least 28 days at 33°F. The probable 33°F shelf life of nonirradiated fresh clam meats would be about nine or ten days. (auth)

10550 ^{192}Ir GAMMA RADIOGRAPHY. I. Tsujimoto, Tadashi; Sumino, Teruie (Kyoto Univ.). Genshiryoku Kogyo, 12: 55-8(Feb. 1966). (In Japanese).

In the radiographic method for detection of defects and flaws in steel products, x-ray generators, γ-ray sources and accelerators such as betatrons are used as the radiation sources. X rays are used for relatively thin products and γ rays (^{60}Co, ^{137}Cs) for thick products, while ^{192}Ir γ rays are particularly useful for products of intermediate thicknesses. Because of its excellent discrimination and striking contrast in radiographs, about 60% of the nondestructive testing sources are ^{192}Ir at the present. However, the half life of ^{192}Ir is short (74.4 days), and therefore, it is necessary to regenerate it in nuclear reactors. The results of various calculations and experiments made on ^{192}Ir are described. An ^{192}Ir nondestructive testing source was prepared by sealing 99.9% iridium powder in an aluminum cylinder. Although ^{192m}Ir, ^{28}Al and ^{194}Ir activities are induced during the activation in a reactor, they all decay out within a week after activation. The activation conditions for preparation of ^{192}Ir in the desired intensities, the intensity and dose rate of the gamma rays, and the absorption in the shielding materials are discussed. (NSA of Japan)

10551 ^{192}Ir GAMMA RADIOGRAPHY. II. Tsujimoto, Tadashi; Sumino, Teruie (Kyoto Univ.). Genshiryoku Kogyo, 12: 60-2; 71(Mar. 1966). (In Japanese).

Iridium-192 with both x and γ rays is widely used as a source for the nondestructive tests. The advantages and disadvantages of ^{192}Ir radiography are described. The contrast in a radiograph is given by $\Delta G = G \log (I_A/I_B)$, where I_A and I_B are the intensities of gamma-rays transmitted through the thicknesses D_A and D_B, respectively. The ^{192}Ir gamma source was found to give the best results. Some of the advantages of the ^{192}Ir gamma source are as follows: the preparation of a high-intensity radiation source of small size is easy; the nondestructive testing apparatus can be small and light due to its simplified shielding; a good contrast is obtained; the ^{192}Ir radiography is applicable to a large variety of objects; and the source is most suitable for the thicknesses of materials which are tested most often. The primary disadvantage of ^{192}Ir is its short half life (74.4 days). (NSA of Japan)

10552 DETERMINATION OF OPTIMUM OPERATING CONDITIONS IN A THERMAL DIFFUSION COLUMN. Saxena, V. K.; Saxena, S. C. (Rajasthan Univ., Jaipur, India). Indian J. Technol., 4: 347-53(Dec. 1966).

The separation in a thermal diffusion column is a complicated function of the geometry parameters, operating conditions and nature of the gas. The procedures used in choosing the dimensions of and operating conditions for the column, so that the separation is maximum for a gas are discussed. The particular case of neon is discussed and the shape factors appropriate for this gas on the inverse power model are used as guides for investigating the dependence of separation on various factors. Some very useful inferences of special value for isotope separation are derived. A similar discussion is also presented for the case in which the interaction potential is approximated by the more realistic Lennard-Jones potential. This study also leads to the same type of qualitative conclusions and this result is important because it tends to establish that minor differences in the interatomic potential are not likely to vitiate the general conclusions drawn. (auth)

10553 POWER FLATTENING DEVICE FOR RADIOISOTOPE HEATED THERMOELECTRIC GENERATOR. Belofsky, H. (to U. S. Atomic Energy Commission). U. S. Patent 3,296,032. Jan. 3, 1967.

A power-flattening system for radioisotope heated thermoelectric generators is described. The system throttles the removal of heat from the radioisotope source through heat transfer device in such a way that the throttling decreases with time in correspondence with the source decay. The heat transfer device thereby expels large amounts of heat initially and smaller amounts with time to provide constant heat ejection system for the source. (TSS)

10554 LOW-ENERGY β-RAY SOURCE. Miwa, Hirohide (to Kobe Kogyo Corp.). Japanese Patent 1966-3199. Feb. 23, 1966. Filed Nov. 9, 1964.

An improved, low-energy β source is described. A high-energy β source is placed in the β shielding container whose window is sealed with a protective foil permitting the passage of β particles. This source container, in turn, is placed in the outer protective container with an irradiation window, whose inside surface has a β scattering layer. The high-energy β particles impinge upon the scattering layer, and the resulting (secondary) low-energy β particles are taken out through the irradiation window for irradiation purposes. (NSA of Japan)

Materials Testing

10555 (AD-630843) EFFECTS OF IMPULSIVE LOADS ON FIBER-REINFORCED CONCRETE BEAMS. Final Report. Romualdi, James P.; Ramey, Melvin R. (Carnegie Inst. of Tech., Pittsburgh, Pa. Dept. of Civil Engineering). Oct. 1965. Contract OCD-PS-64-21. 77p. CFSTI $3.00 cy, $0.65 mn.

An investigation of the effect of a destructive impulse load upon fiber reinforced concrete beams is described. Concrete develops tension cracks as a result of minute flaws that are inherent in its nature. A method of arresting these cracks by placing short lengths of randomly spaced fine wire within the concrete mix is described. The result of the studies indicates that the fibers increase the tensile strength of the concrete by as much as 100 percent for static loading, and the material exhibits considerable post-cracking strength. These two effects increase the ability of the material to absorb energy. (auth)

10556 LOW CYCLE FATIGUE TEST ON NUCLEAR REACTOR PRESSURE VESSELS HAVING VARIOUS NOZZLE CON-

FIGURATIONS. Kameoka, Toshio; Sato, Eiichi (Kobe Steel, Ltd., Japan). Kobe Seiko Giho, 16: 277-90(Oct. 1966). (In Japanese).

Results of an experimental study to determine the low-cycle fatigue characteristics of pressure vessels having various nozzle configurations which are of interest to reactor designers and pressure vessel fabricators are discussed. Numerical data on stress and strain concentration factors, increase of total plastic strain caused by cycling of internal pressure and description of cyclic test facilities are also included. (NSA of Japan)

10557 RECENT ADVANCES IN NONDESTRUCTIVE TESTING TECHNOLOGY AT HANFORD. Worlton, D. C.; Frederick, C. L.; Denton, C. J. (Battelle Memorial Inst., Richland, Wash.). ASTM (Amer. Soc. Testing Mater.) J. Mater., 1: 809-22(Dec. 1966). (BNWL-SA-404).

Methods are described for nondestructive inspection of thin-walled tubing, used principally in heat-exchange systems of nuclear installations. Tests are necessary for the inspection of tubing both before and after installation. Eddy current tests were developed for the inspection of installed tubing, and ultrasonic tests for the inspection of as-fabricated tubing. The eddy current test scans with an internal probe the inside surface of long tubes where only the ends are accessible. By this method, ~600 tubes were tested in a 30-day period on a round-the-clock basis. Serious instances of intergranular corrosion were detected. In no case did destructive examination fail to reveal defects predicted by the eddy current test. Improvements in ultrasonic methods of inspecting uninstalled thin-walled tubing are described. Ultrasonic equipment for inspection of thin-walled tubing was developed and put to routine use. In practice, 2 transducers are used: one sends a beam circumferentially around the tube; the other is directed down the longitudinal axis of the tube. This ensures the detection of defects regardless of their orientation and eliminates the necessity for repeat tests, as is sometimes required. A new emissivity-independent, ir thermal method of nondestructive testing was also developed. The outer surfaces of test pieces are scanned with a heat source and 2 ir radiometers. To obtain the emissivity-independent output the signal from 1 radiometer is delayed, a constant signal is added, and the resulting sum is divided by the output of the second radiometer. (BBB)

10558 COLOR RADIOGRAPHY. Sunada, Tsuyoshi; Kinoshita, Masahiro (Radiation Center of Osaka Prefecture, Osaka). Kagaku Asahi, 26: No. 6, 10(1966). (In Japanese).

A new radiographic material is described which makes possible color radiography. In the field of radiography for nondestructive testing, color radiography is desirable because of improved discernibility of the image over conventional black and white radiographs. As a new approach to this problem, attempts were made to make radiographic films which developed colored images according to the dose of incident radiation penetrating the object to be radiographed. One such film was made from polyvinyl-chloride resin powder which was added to a mixture of aniline blue and methyl yellow dissolved in ethylene dibromide. It was then gently heated until the resin was completely dissolved. This solution was poured onto and spread out over the surface of a flat glass plate and dried. This film changes its original bluish color to red, via green, yellow, and orange, according to the increase of the amount of radiation received. This film has advantages of simplicity of manufacturing and no need for after-processing, such as developing and fixing. When irradiated with strong uv rays, its color changes, but this color change may be easily prevented by sandwiching it between glass plates. Not only flat film, but films of almost any form may be manufactured by this process. (BBB)

Protective Structures

10559 (AD-642431) COOLING ANALYSES FOR PROTECTIVE STRUCTURES LOCATED ABOVE AND BELOW GROUND. Stephenson, J. M. (Naval Civil Engineering Lab., Port Hueneme, Calif.). Nov. 1966. 82p. (R-493). CFSTI $3.00 cy, $0.65 mn.

Techniques were developed for predicting and controlling the effective temperatures in protective structures located both above and below ground. Two techniques were developed by NCEL for underground structures: a trial and error solution and a graphical solution. To check their validity, a two-week field test was performed in a 200-man shelter at the U. S. Naval Construction Battalion Center, Port Hueneme, California. A trial and error solution for underground shelters, published by the ASHRAE, was also checked. Results indicated that all three solutions were satisfactory. For above-ground shelters, a technique described in previous reports was expanded to include more types of structures, and the method of solution was made more flexible. Two instruments to measure thermal properties of soils in situ were developed: a probe to determine thermal conductivity of soil, and a contact device to determine thermal conductivity of soil, and a contact device to determine the coefficient of heat penetration into soil. Both instruments were successfully fabricated and tested. (auth)

10560 (AD-643538) SCATTERED RADIATION (SKYSHINE) CONTRIBUTION TO AN OPEN BASEMENT LOCATED IN A SIMULATED FALLOUT FIELD. Final Report. Schumchyk, Michael J.; Schmoke, Murray A.; Egerland, Walter O.; Schulman, Ernest L. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Dec. 1966. 78p. (NDL-TR-68). CFSTI $3.00 cy, $0.65 mn.

The shielding afforded by an open concrete-walled basement located in a simulated fallout field was determined experimentally. The experimental results were compared with theoretical results published in National Bureau of Standards (NBS) Monograph 42. A cobalt-60 point-source circulation system was used to simulate a uniformly contaminated residual gamma radiation area out to a radius of 600 feet. Experimental exposure-rate measurements were made in the free field and at various locations within the structure as a function of height above the basement floor. Ionization chamber dosimeters were used as radiation detectors. Experimental measurements were extrapolated to infinite-field conditions by use of analytical procedures and compared with other related experimental data and theoretical results. (auth)

10561 (USNRDL-TR-1064) DESIGN OF ROOF WASHDOWN SYSTEMS. Final Report. Heiskell, R. H. (Naval Radiological Defense Lab., San Francisco, Calif.). Jan. 27, 1965. 58p. CFSTI $3.00 cy, $0.65 mn.

Roof washdown studies were conducted on typical roofing surfaces and a basic washdown system was developed. An analysis of the roof washdown countermeasure showed it to be valuable only on buildings with heavily shielded walls or where the occupants are confined to the center of a building with a very large floor area. A complete recirculating roof washdown system will cost only 45% of the cost of a concrete roof that would give a similar reduction of 98% in the roof contribution to gamma radiation exposure inside the structure. (auth)

10562 NUCLEAR RADIATION SHIELDING WINDOW. Mazza, Joseph S. (to Pittsburgh Plate Glass Co.). U. S. Patent 3,283,156. Nov. 1, 1966. Filed Mar. 12, 1963.

A shielding window for use in a zone of radiation higher than 10^6 Roentgens is described. The window consists of a 4 to 6 in. thick slab of cerium-modified soda-lime-silica glass. This glass has low electrical resistivity and high resistance to discoloration on exposure to radiation. (F.S.)

10563 CABIN FOR THE HANDLING OF RADIOACTIVE MATERIALS. (to Siemens-Schuckertwerke Aktiengesellschaft). British Patent 1,051,217. Dec. 14, 1966. Priority date Mar. 8, 1963, Germany.

A cabin used in handling radioactive materials is described. Walls of the cabin shield a worker from radioactivity. Means for moving the cabin over a horizontal surface, as desired, is provided. A fan and blower system is also provided which allows the cabin to move, like a hover craft. Air conditioning and pressurization means are provided. Air tight gloves or externally mounted manipulators which can be actuated mechanically, electrically, or hydraulically from inside the cabin allow the occupant of the cabin to handle radioactive materials located outside the cabin. The cabins are removed through a decontamination area to ensure the protection of the occupants of the cabin. (F.S.)

Radioactive Material Handling

Refer also to abstracts 10413, 10431, 10444, 10501, and 10502.

10564 (CONF-660208-) PROCEEDINGS OF THE SYMPOSIUM ON THE SOLIDIFICATION AND LONG-TERM STORAGE OF HIGHLY RADIOACTIVE WASTES, RICHLAND, WASHINGTON, FEBRUARY 14-18, 1966. Regan, W. H. (ed.) (Atomic Energy Commission, Washington, D. C.). Nov. 1966. 300p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Forty-six papers on the management of highly radioactive wastes are presented. Individual abstracts were prepared for 25 papers. Abstracts of 21 papers appeared previously in NSA: see 19: 33681, 20: 14208, 14466, 16135, 18156, 18158, 18159, 18161, 18165, 18897, 20344, 20345, 20347, 20348, 22509, 22510, 23644, 45230, 45231, 45232, and 45233. (L.C.L.)

For abstracts of individual papers see: 10565-10589.

10565 (CONF-660208-, pp 3-16) FUTURE MAGNITUDE AND PROPOSED SOLUTIONS OF THE WASTE DISPOSAL PROB-

LEM. Blanco, R. E.; Blomeke, J. O.; Roberts, J. T. (Oak Ridge National Lab., Tenn.).

A comparison of the economy and safety of two methods of high-level radioactive waste disposal, i.e., liquid waste storage versus solidified waste storage, is made. The quantities of high-level radioactive wastes resulting from the processing of spent fuels from electric power generating nuclear reactors in the USA through the year 2000 are predicted. (L.C.L.)

10566 (CONF-660208–, pp 17-29) CONSIDERATIONS FOR LONG TERM WASTE STORAGE AND DISPOSAL AT USAEC SITES. Pleat, George B.; Lennemann, William L. (Atomic Energy Commission, Washington, D. C.).

Decisions for long term waste storage and disposal have to be based on the special circumstances of each individual situation rather than on any generalized formula. Considerations of continuing tank storage, waste calcination, radionuclide fixation, waste evaporation, waste fractionization, and waste disposal for the long term storage and surveillance for radioactive wastes are discussed. Particular reference is made to the applicability of these considerations to AEC waste storage sites. Opinions formed have to take into consideration the present condition of the millions of gallons of waste already in tank storage and practical use of the facilities and evironmental conditions at each storage site. Generally speaking, reduction of the wastes to solids and subsequent storage in the present tanks seems to be a safe and feasible approach. Disposal of the wastes as liquids or slurries in suitable deep geologic formations appear to have merit. (auth)

10567 (CONF-660208–, pp 61-73) WASTE MANAGEMENT IN CLOSE-COUPLED NUCLEAR FUEL CYCLES. Slansky, Cyril M. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.).

The management of radioactive waste discharged from a close-coupled fuel cycle is reviewed with emphasis on the quantity, kind, and volume of waste produced and the heat generated by radioactive decay. Several 1000 MW(e) fuel cycles are used as examples and the characteristics of their waste products tabulated. The conclusions reached are: the problems associated with the location of the close-coupled fuel cycle at a nuclear reactor site are appreciably less serious than those for locating the reactor; the inventory of fission products in the reactor is much greater and present in a more volatile form than in the fuel plant; the volume reduction of high-level waste from a 1000 MW(e) fuel cycle installation is limited by removal of decay heat; the waste could be stored underground in a nonleachable form in a volume of 1500–2000 ft^3/yr; and heat dissipation to ground is reasonable after five to ten years of decay. (L.C.L.)

10568 (CONF-660208–, pp 74-81) STORAGE OF HIGHLY ACTIVE WASTES IN THE UNITED KINGDOM. Clelland, D. W. (United Kingdom Atomic Energy Authority, Risley (England). Engineering Group).

A tank used in the United Kingdom to store 150 m^3 of highly active liquid waste at a bulk temperature of 50 to 60°C is discussed. The cooling coil system, the mixing system, and the structural and mechanical design of the tank are described. The cost of the tank is given. (L.C.L.)

10569 (CONF-660208–, pp 82-4) FRENCH HIGH LEVEL WASTE MANAGEMENT PROGRAM. Faugeras, P. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires).

The treatment and storage of Purex Process high- and intermediate-level liquid wastes in France are briefly outlined. The advantages of solidified waste storage are discussed and use of this method is predicted. (L.C.L.)

10570 (CONF-660208–, pp 85-9) GERMAN SITUATION IN THE FIELD OF SOLIDIFICATION AND FINAL STORAGE OF HIGH-LEVEL RADIOACTIVE WASTES. Krause, H. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (West Germany)).

Plants for the disposal of high-level radioactive waste by fixation into glasses and subsequent storage in salt mines in Germany are briefly discussed. (L.C.L.)

10571 (CONF-660208–, pp 89-93) REMARKS AT RICHLAND SYMPOSIUM ON WASTE TREATMENT AND DISPOSAL. McBride, J. A. (Atomic Energy Commission, Washington, D. C.).

Methods of radioactive waste treatment and disposal, both in liquid and solid form, and the AEC licensing of such methods, are discussed. (L.C.L.)

10572 (CONF-660208–, pp 95-119) LABORATORY DEVELOPMENT OF POT PROCESSES FOR SOLIDIFICATION OF RADIOACTIVE WASTES. Clark, W. E.; Godbee, H. W.; Fitzgerald, C. L. (Oak Ridge National Lab., Tenn.).

Pot fixation processes were developed at the Oak Ridge National Laboratory (ORNL). These include calcination (Pot-Cal), rising level glass (RL-Potglass), and continuous glass (CON-Potglass) processes. All three produce only small volumes of off-gas. Volatility of Cs and Rb was prevented in all processes by providing an excess of non-volatile anions over alkalis. Amphoteric oxides (e.g., alumina) are effective as anions. Sulfate volatility was prevented in Pot-Cal by providing an excess of alkalis and alkaline earths over non-volatile anions plus sulfate. This same ratio was effective for sulfate in the glass processes if the operational temperature was not more than about 200°C above the softening temperature. Ruthenium volatility was chemically controlled during evaporation by addition of reducing agents. Normally it is a function of (1) HNO_3 concentration and (2) evaporation temperature. Replacement of mercury from the waste solution by Cu or Al was more practical than trapping it from the off-gas. Molybdenum volatility was less than about 1%. Corrosion of the stainless steel fixation pot was minimized by keeping fixation temperatures ≤900°C and by adding reductants to wastes high in Fe(III) and Cr(VI). Titanium was superior to nickel alloys and stainless steel in condenser and off-gas environments. Melt development emphasized phosphates because melt temperatures can generally be kept low, additives are water- or acid-soluble, and homogeneous melts are possible with high sulfate wastes. Insoluble, low-melting ceramics were developed for a variety of waste types. Operating levels in the rising level pot were determined by means of thermocouples and electrical conductivity probes. External radiation monitoring should be practical. The RL-Potglass Process was operated with melts as viscous as 500-600 poises. Viscosities in the range of 15 to 20 poises are preferable for CON-Potglass. CON-Potglass is potentially simpler than the other processes. Low-melting, non-corrosive melts should make prolonged operation of CON-Potglass possible with melters of Inconel, Corronel-230, or 50 Cr–50 Ni alloy. (auth)

10573 (CONF-660208–, pp 235-46) FLUIDIZED BED CALCINATION OF NEW TYPES OF HIGH-LEVEL WASTES. Bailey, E. J.; Legler, B. M.; Petrie, J. C. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.).

Fluidized bed calcination of new wastes is described with application to the Waste Calcining Facility. Zirconium–aluminum fluoride waste can be calcined satisfactorily if calcium is added first to tie up the fluoride. Aluminum nitrate wastes high in sodium content can be handled by adding sugar to destroy the nitrate during calcination. Aluminum nitrate wastes high in ammonium ion can be handled by adjusting the calciner operating conditions and by blending with standard acidic waste. The stainless steel nitrate–sulfate waste can be calcined if it is blended with standard acidic waste which supplies aluminum to tie up the sulfate. (auth)

10574 (CONF-660208–, pp 301-25) ENGINEERING DEVELOPMENT OF THE POT PROCESSES FOR SOLIDIFICATION OF RADIOACTIVE WASTES. Suddath, J. C.; Hancher, C. W.; Holmes, J. M. (Oak Ridge National Lab., Tenn.).

The pot calcination process is used to solidify radioactive waste solutions by drying and calcining or melting in pots which can be sealed for storage. Experimental data from runs using simulated waste solutions have been correlated using a mathematical model which will allow the prediction of plant capacity when radioactive decay heat is present. Several runs were made using phosphate flux such that the calcined solids would melt to give a glassy solid when cooled. Problems in control of a closely coupled evaporator-pot system were investigated and a satisfactory control system was evolved. Engineering techniques have been developed and tested for handling and sealing the pots. Average processing rates via calcination were 43.0, 21.9, and 16.2 liters per hour for Purex, Darex and TBP-25 simulated wastes, respectively. For fixation in glass, the average processing rates were 25.0 and 6.0 liters per hour for Purex and TBP-25 wastes, respectively. Preliminary tests were made on a continuous glass process, with rates up to 40 liters per hour using TBP-25 type waste. (auth)

10575 (CONF-660208–, pp 326-74) DEVELOPMENT OF A SPRAY CALCINER-MELTER. Kaser, John D.; Moore, James D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Engineering development of a spray calciner with continuous fusion of the calcine to a melt has been performed over a three-year period. An off-gas filtration system was developed which uses porous stainless steel filters, cleaned by intermittent reverse steam or air jets. Corrosion rates for various construction materials have been explored. Data on the effects of feed composition, process temperature, auxiliary equipment, size, and internal geometry, will permit further demonstration with radioactive wastes. (auth)

10576 (CONF-660208–, pp 375-86) PROSPECTS OF BITUMEN AS COATING MATERIAL FOR RADIOACTIVE WASTE. Rodier, J.; Lefillatre, G.; Estournel, R. (Commissariat a l'En-

ergie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule).

An investigation of the use of bitumen for the solidification of of sludges having radioactivity ranges from 10 Ci/m^3 to 400 Ci/m^3 was conducted. The behavior of the bitumen coated radioactive matter was examined for the effects of high temperature, irradiation, and content of the fission product solutions. Four methods of bitumen coating were studied; adsorption on clay, adsorption on co-precipitates, direct coating, and calcination. Their advantages were compared with those of the vitrification process. The bitumen solidification process is simpler than vitrification and requires lower temperatures. Bitumen calcination results in a more compact waste solid. However, distillation of the heavy oils contained in the bitumen is required when temperatures of 250°C are exceeded in the coating process, at which point an explosion risk exists. Further studies of this process are recommended. (L.C.L.)

10577 (CONF-660208–, pp 388-99) INITIAL OPERATION OF THE IDAHO WASTE CALCINING FACILITY WITH RADIOACTIVE FEED. Lohse, G. E.; Commander, R. E. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.).

The world's first major breakthrough in treating aqueous radioactive wastes has been accomplished at the Idaho Chemical Processing Plant (ICPP) where the Waste Calcining Facility converts these solutions to a safer solid form having one-ninth the volume previously stored. The first processing campaign lasted 312 days with an on-stream factor of 99.2 percent. Approximately 512,000 gallons of waste containing up to 40 curies of radionuclides per gallon were calcined in an air-fluidized bed heated at 400°C. The resulting granular metallic oxides were transported pneumatically to underground storage bins. Off-gases were successfully decontaminated and discharged to the atmosphere. Environmental monitoring indicated no significant hazard from operation of the facility. (auth)

10578 (CONF-660208–, pp 427-46) FINGAL PROCESS. Grover, J. R.; Hardwick, W. H.; Gayler, R.; Delve, M. H. (Atomic Energy Research Establishment, Harwell (England)).

The results and practical experience gained during four years operation of the FINGAL pilot plant and the supporting inactive plant are described. 72 runs have been carried out, 8 of which have been with actual radioactive fission product solutions. 30,000 curies have been processed, the final run of the program involving 14,500 curies in 52 liters of solution to produce 42 kg of glass. The decontamination factor to the condensate for fission product elements other than ruthenium has been 10^{10} and for ruthenium has varied from 10^4 to 10^8. For all activity, the decontamination factor to the effluent has been from 10^{14} to 10^{16}. Operating problems due to the presence of ruthenium have been overcome and the process is now ready for commercial exploitation. (auth)

10579 (CONF-660208–, pp 447-512) DESIGN FEATURES OF THE WASTE SOLIDIFICATION ENGINEERING PROTOTYPES. Schneider, K. J.; Kelly, V. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

General design criteria and objectives of the Waste Solidification Engineering Prototypes equipment are discussed. Design criteria are based upon providing a developmental facility with a high degree of flexibility and integrity for demonstrations of various waste solidification processes and equipment with fully radioactive materials. Special features of the equipment for process and mechanical functions to be performed during the demonstrations are presented. Process functions include overall flowsheet requirements, process effluent treatment and control, and special features of process equipment. Mechanical functions include remote handling and transfer of material and equipment, and storage and testing of containers full of solidified waste. (auth)

10580 (CONF-660208–, pp 513-25) DESIGN VERIFICATION TESTING OF WASTE SOLIDIFICATION PROCESSES. Rey, G.; McElroy, J. L.; Mendel, J. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Design verification tests in Waste Solidification Engineering Prototypes equipment have been made for pot and spray solidification processes. Chemical flowsheets for pot calcination, rising level glass and continuous spray solidification were tested successfully using simulated waste. Equipment performance has met expectations and specific process characteristics under waste solidification processing are discussed. (auth)

10581 (CONF-660208–, pp 549-65) EFFECTS OF COMPOSITIONAL VARIATION ON "DRIP TEMPERATURE" AND LEACHABILITY OF PHOSPHATE SOLIDS UNDER CONSIDERATION FOR FIXATION OF RADIOACTIVE RESIDUES. Barton, G. B. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Phosphate solids that offer promise as desirable "fixation" forms can be formed from a variety of compositions. There are minima in the "drip temperature" and leachability of some of these solids near phosphate additions corresponding to M^+/P ratio of 2.3 and 1.0. There is an upper limit (near fifty percent) to the fission product oxide fraction that can be successfully processed. The thermal history of the melt has very significant effects on the properties of the final solid. Slow cooling to produce crystallized material generally reduces the "drip temperature" and increases the leachability of the final solid. (auth)

10582 (CONF-660208–, pp 566-84) PHYSICAL PROPERTIES OF SOLIDS INCORPORATING SIMULATED RADIOACTIVE WASTES. Godbee, H. W.; Clark, W. E.; Fitzgerald, C. L. (Oak Ridge National Lab., Tenn.).

Tests were made to determine the physical properties of the glassy solids formed in the solidification of simulated radioactive waste. Most of the glassy solids were phosphates, but a few were silicates. Among the more important properties investigated were melting or softening point, density, fraction of the product that is from the waste, solubility in water, thermal conductivity, and viscosity as well as density of the molten material. The melting or softening point of these glassy solids ranged from 600 to 1050°C. Densities of the solids were about 2 to 5 g/cc. The weight fraction of the product that represents solids from waste varied from about 0.15 to 0.70. Solubilities, as indicated by leach rates, changed markedly with composition. For the best products, these leach rates are of the same magnitude as those of commercial glasses, that is, 10^{-4} to 10^{-7} g cm^{-2} day^{-1}. Thermal conductivities ranged from about 1 Btu hr^{-1} ft^{-1} $°F^{-1}$ to about 1.7 Btu hr^{-1} ft^{-1} $°F^{-1}$ over the temperature range of interest—about 200 to 1600°F. Viscosities of the melts varied from about 5 to 225 poises at 900°C. These properties show that glassy solids which are relatively low-melting, insoluble, pore-free, and dense can be formed containing a large fraction of solids that are from waste. The better products represent volume reductions comparable to those obtained with calcined waste. Their thermal conductivities are 2 to 10 times higher than those of calcines or powders representing similar volume reductions. The viscosities of the phosphate melts measured are some 100 to 1000 times lower than those of common commercial glasses. (auth)

10583 (CONF-660208–, pp 585-605) LONG TERM EXAMINATION OF GLASSES FOR THE FINGAL PROCESS. Grover, J. R.; Elliot, M. N. (Atomic Energy Research Establishment, Harwell (England); Jones, A. D. (Sondes Place Research Inst., Dorking (England)).

Glasses to be used for the safe storage of fission products must maintain their stability in spite of severe conditions of temperature and radiation. Activity can be released from glass in storage either by leaching or by volatilization. A sophisticated technique is described for measuring very low leach rates after glasses have been subjected to high radiation doses and a variety of thermal treatments. Results so far show that seawater is no more corrosive than distilled water and that the whole of the glass matrix is slowly removed. The release of major constituents from heated glasses by volatilization will be followed by a study of fission product volatility. (auth)

10584 (CONF-660208–, pp 623-41) STORAGE AND FURTHER TREATMENT OF PRODUCT FROM FLUIDIZED BED CALCINATION OF RADIOACTIVE WASTES. Rhodes, D. W. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.).

High-level radioactive aqueous waste at the Idaho Chemical Processing Plant (ICPP) is converted to a granular solid by fluidized bed calcination in the Waste Calcining Facility (WCF). The product is stored in stainless steel bins at centerline temperatures below 400°C. The results of measurements involving properties of the calcine that influence storage such as heat generation rate, bulk, density, thermal conductivity, changes in crystallinity and diffusion of volatile fission products along a temperature gradient are given. The design of improved storage bins having a centerline temperature of 700°C is reported, and laboratory-scale studies to determine the feasibility of converting the granular product to an even safer solid form by imbedding the particles in a solid matrix or fusing to form a glass are described. (auth)

10585 (CONF-660208–, pp 642-58) OBSERVED PROPERTIES OF SOME SOLIDIFIED HIGH-LEVEL WASTES AND THEIR STABILITY UNDER SIMULATED STORAGE CONDITIONS. Upson, U. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Selected calcines produced by spray and pot calcination of high-level Purex and Redox process wastes were examined for density, leachability and visual appearance, and sealed pots containing calcines were monitored for pressure buildup. A sample of phosphate glass produced from the high-level Purex waste was examined for mechanical stability and for leachability over a one year period. Volume reduction factors and leach rate data are given. (auth)

10586 (CONF-660208–, pp 660-70) PROBLEMS OF FINAL STORAGE OF RADIOACTIVE WASTES IN SALT FORMATIONS. Borchert, H. (Gesellschaft fuer Strahlenforschung m,b,H., Clausthal-Zellerfeld (West Germany). Institut fuer Tierflagerung).

In connection with the storing of radioactive wastes in German salt mines the following mechanical properties of salt rocks have been especially studied: yield points of halite, sylvite, carnallite, etc.; the characteristic stress/strain curves for evaporites in dependence of the rate of stress increase; the uniaxial, biaxial and in some cases also the triaxial breaking strengths of halite rocks and the systematic investigation of the conversion relations of uniaxial and biaxial stresses; the influence of temperature on deformation; the strengthening by increased deformation (strain hardening) and the weakening through recrystallization; and measurements of absolute stresses around mining rooms and in pillars by different methods. (L.C.L.)

10587 (CONF-660208–, pp 760-86) HEAT TRANSFER IN UNDERGROUND TANK STORAGE OF RADIOACTIVE WASTES. Jansen, G.; Willingham, W. E.; DeMier, W. V. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Steady-state temperatures in and around tanks containing solidified fission product wastes have been calculated as a function of heat generation rate, cake thickness, soil cover depth, and thermal conductivity of the soil. A simplified heat flow model which allows variation of parameters without iterative calculations is proposed. Temperature rises in hemispheroidal leaks from underground liquid waste storage tanks have been estimated as a function of leak size and shape. Methods for using temperature records in determining the size and location of leaks are outlined. (auth)

10588 (CONF-660208–, pp 800-29) A LOOK AT LONG RANGE WASTE MANAGEMENT COSTS AT USAEC SITES. Lennemann, William L. (Atomic Energy Commission, Washington, D.C.).

During the 1963 to 1964 period, the USAEC contractor organizations at Hanford, Savannah River, and the National Reactor Testing Site (Idaho) examined the long range financial implications of continuing with present tank storage practices for the highly radioactive waste effluents from the irradiated fuel processing plants in comparison with conceptual alternatives. Generally, more permanent storage of these wastes as an immobile form was indicated to be less expensive by annual expenditures than continuing the present practice of liquid storage because of the long range costs of new generations of storage tanks and continuing surveillance and transfer of these liquids for the hundreds of years that they are a hazard. When the costs were compared on a present worth basis, indications were that immobilizing the bulk of the waste in the present tanks would be the least expensive alternative for Hanford and Savannah River but, for Idaho, it cost less to continue to store the acidic waste liquors in stainless steel tanks. These indications resulted from the use of highly theoretical assumptions and calculations. (auth)

10589 (CONF-660208–, pp 844-57) ECONOMICS OF WASTE MANAGEMENT INVOLVING FLUIDIZED BED CALCINATION. Lockard, J. L.; Garner, J. W. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.).

A cost study made recently at the Idaho Chemical Processing Plant (ICPP) is summarized. The economics of waste containment as acidic liquid, as neutralized liquid, and as solids produced by fluidized bed calcination are compared. Costs based on actual ICPP experience are used. Wastes considered are those produced at the ICPP, but some correlations are generalized to permit their application to other wastes at other sites. Distinct advantages in both economics and safety are indicated for storage as calcined solids. To determine the optimum approach for this type of storage, economic effects of interim liquid storage, interim solids storage, and different solids storage temperatures have been investigated. (auth)

10590 (EUR–3175.e) SLUDGE CONCENTRATION WITH A CENTRIFUGAL SEPARATOR. Cardozo, R. Lopes; Vaccarezza, J.; Vanuzzi, S. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1966. 16p. Dep. mn.

A description of a centrifugal separator for the volume reduction of sludges emanating from the decontamination of radioactive waste water by coprecipitation is presented. Its main features are: overall volume reduction factor of 500; solids content of concentrated sludge of 11 to 16 wt %; minimalization of radioactive hazards; ease of operation; and low cost of treatment. (auth)

10591 (IN–1032) MATHEMATICAL AND EXPERIMENTAL ANALYSIS OF HEAT DISSIPATION FROM CYLINDRICAL SOURCES BURIED IN SOIL. Black, D. E.; Dickey, B. R. (Idaho Nuclear Corp., Idaho Falls). Dec. 1966. Contract AT(10-1)-1230. 140p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Mathematical models are proposed for predicting the steady-state and transient temperature distributions in small- and large-diameter, cylindrical, nuclear heat sources and the surrounding soil. Computer programs are used to solve the two-dimensional, time-dependent heat-transfer equations resulting from the models. The thermal conductivity, specific heat, and moisture content were experimentally determined for soils at an experimental test site. These properties were required for calculating the temperatures in and surrounding a buried electrical heater. Agreement between calculated and measured temperatures was good, generally within a few degrees. The quantitative effects of soil and heat source thermal conductivity, time-dependent heat generation rate, heat source dimensions, and burial depth on the calculated temperature distributions in and surrounding buried heat sources are illustrated by numerical examples. (auth)

10592 (LA-DC–8386) CORRELATIONS OF EXPERIMENTS AND CALCULATIONS. Stratton, William R. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 43p. (CONF-661206–3). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Nuclear Society, National Topical Meeting, Nuclear Criticality Safety, Las Vegas, Nev.

A theoretical technique to interpret critical data using one-dimensional codes for spheres, slabs, and infinite cylinders of ^{235}U, ^{233}U, and ^{239}Pu was compared with data determined experimentally. Calculations for highly enriched ^{235}U thermal and fast systems, even though cross sections for fast and epithermal cores were chosen, gave satisfactory results. A tendency for progressive overestimates of critical radii with decreasing enrichment was seen. A trend of increasing error with decreasing $H/^{235}U$ ratio for systems enriched to 5% ^{235}U or less was noted. For a given ^{235}U enrichment, a calculational bias may be determined and applied with confidence. (F.S.)

10593 (ORNL-TM–1697) INCORPORATION OF INTERMEDIATE-LEVEL WASTE IN ASPHALT: PRELIMINARY DESIGN AND COST ESTIMATE OF A FULL-SCALE PLANT FOR ORNL. Rom, A. M. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 25p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A conceptual design of a plant to immobilize locally produced, intermediate-level radioactive waste (ILW) as part of the development of the waste-asphalt process at ORNL is described. The waste-asphalt process is an evaporation process. A wiped-film evaporator operating at 320°F mixes emulsified asphalt with concentrated ILW from the ORNL Waste Evaporator, volatilizes the water, and yields a product (consisting of waste solids dispersed in asphalt) that, after being collected in 55-gal drums, is suitable for either long-term storage or burial. It was assumed, in the plant design, that the concentrated waste from the ORNL Waste Evaporator contained 40% dissolved salts and 0.1 to 5 curies/gal of one of the following: ^{106}Ru, ^{137}Cs, ^{90}Sr, or mixed fission products. The ILW processing rate was 60 gph for 278 days/year (or 76.1% of the available time). A new building, meeting ORNL double-containment criteria, was designed to include a central cell (10 × 10 × 16 ft) with 3-ft-thick concrete walls, a shielding window, a pair of master-slave manipulators, a general-purpose operating-control room, a shielded tunnel for handling product drums remotely, and a crane bay with a 5-ton bridge crane. Temperature rise in the product drums will be negligible. Radiation damage to the product restricts the quantity of radioactive material that may be dispersed into asphalt. However, calculations indicate that permissible limits will not be exceeded. A maximum value, 1.3×10^9 rads, was calculated for ^{90}Sr, assuming total decay. The total capital cost for building and equipment was estimated to be $330,500. The unit operating cost, based on processing 400,000 gal of ILW per year, was estimated at $0.34/gal, assuming 20-year amortization of capital without interest, or $0.37/gal, assuming 20-year amortization with 4% interest. (auth)

10594 (USNRDL-TR–1098) BETA SPECTRA. IV. DEGRADED SPECTRA FROM A FINITE SPHERICAL SOURCE. Hogan, O. L. (Naval Radiological Defense Lab., San Francisco, Calif.). Oct. 10, 1966. Contract AT(49-5)-2505. 32p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A FORTRAN II program was written to compute the degradation undergone by a theoretical beta spectrum in emerging from a spherical particle of high density, high Z material. Inputs to the program are the point source (or undegraded) beta spectrum and the coefficients of a degradation function. Outputs from the program are the degraded spectrum and its expected and median energies. Data are presented for degradation of beta spectra originating within uranium carbide particles. (auth)

10595 SELECTIVE ION-EXCHANGE SORPTION OF ^{137}Cs AND ^{131}I FROM BORATED SOLUTIONS. Dickinson, B. N. (Diamond Alkali Co., Redwood City, Calif.); Higgins, I. R. Nucl. Sci. Eng., 27: 133-2(Jan. 1967).

Packaging of radioactive by products from nuclear reactors in

easily disposable units of minimum volume is discussed. Ion exchange has proved to be very useful for this purpose, especially for treating low activity wastes. An investigation directed toward improving ion exchange techniques is described. Cesium-137 and iodine-131 were selected for this study. Radioactive feed solutions were percolated through beds of resins. Flow rates ran from 7 to 14 ml/min, averaging 1.5 gal/(min ft^3). Cation exchangers used were Duolite C-3R and CS-100R, both in hydrogen form. The tests demonstrated that phenolic cation exchangers have a high selectivity for traces of ^{137}Cs contained in heavy concentrations of borates at alkaline pH values; also that an epoxy intermediate-base anion exchanger has a surprising degree of specificity for small traces of ^{131}I dissolved in a large excess of boric acid. (R.C.K.)

Vacuum Engineering

10596 (IA-1089) FORCE CYCLE OF VACUUM GASKET SEALS. Roth, A.; Inbar, A. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). July 1966. 32p. (CONF-661038-1). Dep. mn.

From 13th Symposium of the American Vacuum Society, San Francisco, Calif.

The method of "sealometry" recently developed for the analysis of gasket seals has shown that an appropriate representation of the force cycle of a vacuum gasket seal gives multilateral information on the factors influencing it. The various types of force cycles are discussed and the analytical correlation between the shape of the cycle and the phenomena determining the sealing effect is shown. A graphical method for plotting the releasing path of the cycle from the tightening path, and vice versa, is given. Experimental results are compared with calculated values. Standard parameters are proposed for describing the force cycle, and the most characteristic cycle shapes are presented. The use of the force cycle in establishing the suitability of seals for specific purposes (repeated opening, baking, cryogenic, etc.) is discussed. (auth)

10597 WARM-WELDING OF METALS IN ULTRAHIGH VACUUM. Batzer, Thomas H.; Bunshah, R. F. (Univ. of California, Livermore). J. Vac. Sci. Technol., 4: 19-28(Jan.-Feb. 1967). (UCRL-14304).

Before metal surfaces can be welded, it is necessary to remove the contamination (oxide) layer on the surface and avoid recontamination of the clean surface by its environment prior to the welding operation. Mechanical abrasion is one way of removing the surface oxide layer used in such processes as friction-welding, roll-bonding, and diffusion-bonding. It would be desirable to have a technique for welding at low temperatures (0.1 to 0.4 T_m), with non-distorting, zero-shear type of leading. In an ultrahigh vacuum environment (to delay recontamination to very long times), two halves of a tensile specimen are cleaned by argon-ion bombardment, compressed at about 0.8 to 0.9 yield strength at 0.1 to 0.4 T_m, and held at temperature for finite times. The welded specimen is then tensile-tested in the ultrahigh vacuum system to evaluate the process. The variables studied are temperature, time, loading, and the need for ion cleaning on various metals. Successful welds were produced in OFHC copper, Ti, and Be. (auth)

10598 DENSITY OF THIN IRON FILMS. Wraight, N. A. (British Scientific Instrument Research Association, Kent, Eng.). J. Vac. Sci. Technol., 4: 41-2(Jan.-Feb. 1967).

The effect of improved vacuum conditions on film density was studied. Iron films were deposited on soda glass at room temperatures, at vacuum pressures of 5×10^{-9} torr and 2×10^{-5} torr at a rate of ~0.12 $\mu g/cm^{-2}/sec^{-1}$. Film densities were calculated from measurements of mass unit area by a calorimetric method. It was found that the iron density in films deposited at the lower pressure was the same as the bulk material to within experimental error at least down to a thickness of 200 Å. Films prepared at higher pressure were ~5.59/cm^{-3} for the thickness range 200 to 700 Å. The effect of impurities on film density was slight. It was found that a porous film structure forms at higher pressures. (F.S.)

10599 BAKEOUT PROCEDURE FOR SMALL GLASS ULTRAHIGH-VACUUM SYSTEMS. Steinrisser, Fortunat (Univ. of Illinois, Urbana). J. Vac. Sci. Technol., 4: 44-5(Jan.-Feb. 1967).

A vacuum bakeout procedure for small glass ultrahigh vacuum systems is described. A stable pressure around 1×10^{-11} torr was obtained. Oil contamination was reduced and the O_2-to-CO conversion rate in the presence of a hot filament was only 2% or less. The main residual gases were He and H_2 at about equal pressures. (F.S.)

10600 CRYOGENIC LOW-PRESSURE SEAL. Moore, B. C. (Douglas Aircraft Co., Inc., Huntington Beach, Calif.); Bergquist, L. E.; Clements, P. R. J. Vac. Sci. Technol., 4: 45-6(Jan.-Feb. 1967).

A simple reliable metallic seal was developed to seal aluminum and stainless steel flanges for use at low pressures and cryogenic temperatures. The seal uses a soft metal wire gasket retained in a rectangular groove in an aluminum spacer. Flanges may vary from 2 to 35 in. in dia. Stainless steel flanges may be sealed to stainless steel or aluminum and aluminum may be sealed to aluminum. Sealed flanges were temperature-cycled from 300°K to 77°K and from 300°K to 400°K. No leaks were found when checked with a helium leak detector whose ultimate leak rate sensitivity was less than 10^{-9} atmospheric cc/sec. (F.S.)

10601 PUMPING SPEEDS OF GETTER-ION PUMPS AT LOW PRESSURES. Dallos, Andras; Steinrisser, Fortunat (Univ. of Illinois, Urbana). J. Vac. Sci. Technol., 4: 6-9(Jan.-Feb. 1967).

Pumping speeds of commercial diode and triode type getter-ion pumps were measured for the gases H_2, He, and N_2 over the pressure range from below 10^{-10} torr to 10^{-6} torr. At 10^{-10} torr, the pumping speed was about 20% of the speed at 10^{-6} torr, where the pumps attained approximately the rated speed. Pumping speed measurements as a function of time showed that the pumping speed decreased generally less than 25% over a period of one day. Strong saturation was found only for He at pressures above 10^{-7} torr. No significant differences between diode and triode in the pumping speed vs time or pressure curves were observed. In the diode, pump currents were measured. The quantity $P \times S/I$ was found to be pressure independent for short pumping times. The numbers (in molecules or atoms pumped per charge) are: 0.5 (H_2), 0.6 (He), and 0.2 (N_2). (auth)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 11426, 11502, 11705, 11991, 12011, 12033, 12098, and 12262.

10602 (BNL–10751) BNL'S LARGE BUBBLE CHAMBER PROGRAM. Fowler, W. B. (Brookhaven National Lab., Upton, N. Y.). Sept. 11, 1966. Contract AT(30-2)-Gen-16. 18p. (CONF-660918–15). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Conference on Instrumentation for High Energy Physics, Stanford, Calif.

A summary of progress is presented on the design of a 14-foot diameter cryogenic bubble chamber for use with hydrogen, deuterium, or neon–hydrogen mixtures. Topics included are expansion system, optical system, magnetic fields produced by superconducting coils, and refrigerators. (B.G.D.)

10603 (GA–6641) THEORETICAL TIME DISTRIBUTIONS OF INELASTICALLY SCATTERED NEUTRONS WITH RELATED RESOLUTION CONSIDERATIONS. Rothbart, G. B. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Sept. 17, 1965. Contract AT(04-3)-167. 22p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A mathematical treatment of the behavior of dispersive neutron pulses for single-chopper velocity selector systems has been developed for both elastic and inelastic scattering. The analysis includes effects due to a finite production time of neutrons at the source, and a finite uncertainty in the energy transfer; however, the effects of beam width and scattering angles is considered to be negligible. The predicted neutron burst is compared with experimental data. A procedure is developed by which the widths of Einstein bound levels can be reliably determined. (auth)

10604 (IS–1478) NUCLEAR SPECTROSCOPIC STUDIES WITH A SEMICONDUCTOR DETECTOR COINCIDENCE SYSTEM. Englert, Thaddeus Joseph; Everling, F.; Eakins, G. W.; Hatch, E. N. (Ames Lab., Iowa). Nov. 1966. Contract W-7405-eng-82. 89p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A coincidence spectrometer has been constructed which utilizes the properties of semiconductor detectors and sodium–iodide scintillation detectors. Measurements of relative intensities of conversion electrons from ^{207}Pb and ^{175}Lu were determined using this system and the values found are in good agreement with measurements made with magnetic spectrometers. To demonstrate further its versatility, the coincidence system was used to study the Compton effect using the 570-and 1064-keV gamma rays from ^{207}Pb. The problem of obtaining a pure electron spectrum with semiconductor detectors when the electrons are being emitted in the presence of a photon spectrum was studied and two methods of suppression of the photon background were investigated. Electron-electron coincidence measurements using semiconductor detectors and electron-gamma coincidence measurements using a sodium–iodide scintillation counter in conjunction with a semiconductor detector were made to study the decay scheme of ^{175}Lu following the electron capture decay of ^{175}Hf. (auth)

10605 (JINR–P13-3068) STRIMERNAYA KAMERA S KONVERTORAMI γ-KVANTOV. (Streamer Chamber With γ-Quantum Converters). Vishnevskii, V.F. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1966. 7p. (In Russian). Dep. mn.

A design of a streamer chamber is described which allows one to put γ-quantum converters in the form of lead glass plates into the chamber volume. The chamber was tested in cosmic rays. (auth)

10606 (LA–3595) MODIFIED-SPHERE NEUTRON DETECTOR. Hankins, Dale E. (Los Alamos Scientific Lab., N. Mex.). Oct. 1966. Contract W-7405-eng-36. 39p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Calculations were made using the adjoint-transport program to determine the response of a neutron detector utilizing cadmium-loaded polyethylene spheres of 8-, 9-, and $9\frac{1}{2}$-in. diameter. The effect on the energy response of the detector is given as a function of cadmium thickness and location of the cadmium in the sphere. The effect on the energy response of a void in the sphere, substitution of boron for cadmium, and the use of a perforated cadmium layer were also calculated. A 9-in., cadmium-loaded sphere was made using the calculated cadmium location and thickness. The response curve to fast and thermal neutrons was compared to the calculated value. The 9-in., cadmium-loaded sphere was found to have a response similar to that of the 10-in., rem-responding sphere. (auth)

10607 (N–66-19650) [THEORETICAL AND EXPERIMENTAL INVESTIGATION OF PARTICLE DETECTION AND PARTICLE DETECTORS TO IMPROVE EFFECTIVENESS, ACCURACY, AND DISCRIMINATION]. Status Report No. 5, Period Ending November 30, 1965. Ziock, K.; Ritter, R. C. (Virginia Univ., Charlottesville. Dept. of Physics). [1965]. 19p. (NASA-CR–70719). CFSTI $3.00 cy, $0.65 mn.

New techniques, testing, and fabrication are reported in the development of Li drifted Ge particle detectors. Relative research is detailed, results of tests are given, and problem areas are cited. Advantages over planar and five sided coaxial detectors are summarized. (STAR)

10608 (ORNL–TM–1710) CALIBRATION OF IODINE MONITOR, ORNL MODEL Q-2725. Gillespie, F. E. (Oak Ridge National Lab., Tenn.). Dec. 14, 1966. Contract W-7405-eng-26. 9p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

All stacks for radioactive off-gas disposal at ORNL are equipped with Iodine Monitors, ORNL model Q-2725, to sound an alarm when an excessive quantity of ^{131}I is released from the stack and to provide count-rate data for calculation of the quantity of ^{131}I being discharged from the stack. The sensitivity of one such monitor was determined by releasing microcurie amounts of ^{131}I directly to the charcoal trap and counting the radioactivity of the trapped iodine. With Barneby-Cheney No. 727 charcoal in the trap, the sensitivity was 425 counts min^{-1} μc^{-1} of ^{131}I. (auth)

10609 (TID–23367) THE MEASUREMENT OF ENVIRONMENTAL RADIATION. Annual Report. (New York Univ., N. Y. Graduate School of Arts and Science). July 20, 1959. Contract AT(30-1)-1704. 62p.

A technique was developed for the accurate measurement of environmental radiation. The technique involves operation of a standard ion chamber under conditions that suppress the ionization due to local alpha contamination and yet yield results that are readily interpreted in terms of dosimetric significance. Effectiveness of the technique as applied to the large cylindrical chamber was confirmed by detailed recombination studies using a small parallel-plate chamber, in which the recombination of ions produced separately by alphas and betas were investigated in various gases. Status of the calorimetric study of the energy equivalent of the roentgen is reviewed. (H.G.D.)

10610 (UCRL–17129) A LIQUID HYDROGEN FOCUSING CHERENKOV COUNTER. Kenney, R. W.; Caldwell, David O.; McLaughlin, E. E.; Pope, W. L.; Schafer, R. V.; Stearns, B. F. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1966. Contract W-7405-eng-48. 6p. (CONF-660918–16). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Conference on Instrumentation for High Energy Physics, Stanford, Calif.

A liquid hydrogen focusing Cherenkov counter is described which was used in a study of CPT invariance by measuring the intensities of surviving pions in a parallel and monoenergetic beam in order to determine the ratio of total proper lifetimes of π^+ and π^- mesons. (B.G.D.)

10611 COSMIC SHOWER γ SPECTROMETERS, THE THEORY, AND BASIC SPECIFICATIONS. Grushin, V. F.; Leikin, E. M. Tr. Fiz. Inst., Akad. Nauk SSSR, 34: 187-201(1966). (In Russian).

In an atmospheric shower a gamma quanta with energy E is converted into a suitable output signal Q by the following steps: $E \xrightarrow{1} N \xrightarrow{2} N\nu g \xrightarrow{3a} n\nu g\psi \xrightarrow{3b} N\nu g\psi\rho \xrightarrow{3c} N\nu g\psi\rho \xrightarrow{4} Q$. Here $Q = N\nu g\psi\rho M$ in units of electron charge. The number of charged particles N is proportional to the energy E. Each shower particle generates ν photons which produce light at an efficiency g. The photons are converted to photoelectrons with an efficiency ψ. The photoelectrons are collected by the multiplying system with an efficiency ρ. M is the amplification factor. Statistical concepts are applied to the above steps, and the frequency distributions for the whole process is derived from the individual frequency distributions. Steps 3a, 3b, and 3c are combined. The mathematical theory of branching processes is used. A general expression is obtained for the form of a gamma line on a spectrometer used for counting atmosphere shower particles. The light yield and normal distribution characterizing the output signal per individual shower particle are averaged. Calculations on a digital computer illustrate the effect of the transparency of the radiation absorber on the design of Cherenkov spectrometers. In the case of the more transparent glass, particle escape from the radiation absorber begins at lower energies than in the case of the less transparent glass. Moreover, an improvement in the energy resolution of the

instrument due to an increase in size is possible only with sufficient transparency of the glass. Finally, the symmetrical line form is sometimes a result of the low transparency of the glass absorber. (TTT)

10612 METHOD FOR MEASURING THE TOTAL NUMBER OF PARTICLES AND THE COORDINATE AXIS POINT OF WIDE ATMOSPHERIC SHOWER. Aglamazov, V. A.; Gedevanishvili, L. D.; Kokhodze, L. Sh.; Pobakidze, Z. P.; Sakvarelidze, I. I.; Khazaradze, N. G. (Tbilisi State Univ., USSR). Soobshch. Akad. Nauk Gruz. SSR, 44: No. 1, 43-9(Oct. 1966). (In Russian).

The most probable local density of particles can be determined by counting on a hodoscopic array of $\underline{m}$ Geiger–Mueller counters having an individual area of $\underline{s}$ in m^2. The local particle density Δ_m is: $\Delta_m = (1/s) \ln [m/(m-n)]$. Here n is the number of counters which were triggered in the total array of $\underline{m}$ counters. The distance from the detector to the shower axis is given by the following expression: $R = 1.19 [N/\Delta_m \times 10^5]^{0.307} - 0.32$. Here N is the total number of charged particles in the shower, and $R = r/r_0$. For air the value of r_0 is 9.5 g/cm², or $r_0 = 80$ m, and r is the distance from the detector to the axis of the shower. Formulas are given from which it is possible to determine the total number of charged particles N in a shower and the distance to the shower axis from the local density measurements at three different points separated a distance $\underline{a}$ from each other. (TTT)

10613 USE OF STATISTICAL CHARACTERISTICS OF GAS DISCHARGE GAPS FOR COMPUTING SCHEME WITH DOUBLE PULSED DEKATRONS. Zapevalov, V. A. Tr. Fiz. Inst., Akad. Nauk SSSR, 34: 220-40(1966). (In Russian).

A dekatron is a decade, gas-discharge counting device. The movement of charge from one cathode to the next in a two-pulse dekatron takes place by means of two pulses shifted in time. The static characteristics of the gas-discharge interval of the dekatron with graphical methods of calculation can be used to give design data on circuits and charge transitions. The firing and extinction characteristics of the charge are used graphically to determine the charge transfer from the cathode to the first sub-cathode, and from the first sub-cathode to the second sub-cathode. The currents are given as functions of the applied voltage. The currents of the first and second sub-cathodes are also given for various values of the internal resistances. The charge transfer from the second sub-cathode to a subsequent cathode is analyzed. The forms of current pulses are calculated, and are shown to be in good agreement with the pulse shapes obtained experimentally. These charge forms are very favorable for stable advance of the charge in the dekatron. The charge pulses exist separately in time on each of the sub-cathodes. Drop of the dekatron to zero is accomplished by breaking the circuit common to all the cathodes, by breaking the cathode and sub-cathode circuit, or by applying a pulse to the cathode circuit or to the neutral cathode. Stability of operation of the dekatron is analyzed. Various transistorized dekatron counters are presented and analyzed. (TTT)

10614 IONIZATION DEFECT IN ARGON–ACETYLENE MIXTURE. Yaneva, N. V.; Dermendzhiev, E. G.; Ivanov, I. M. (Inst. of Physics, Academy of Sciences, Bulgaria). Compt. Rend. Acad. Bulg. Sci., 19: 715-18(1966). (In Russian).

The reason for differences observed in the kinetic energy values of fission fragments, determined by calorimetric or time-of-flight methods and by means of a pulsed ionization chamber, was examined. This so-called ionization defect was attributed to the interaction of the fission fragments with the gas of the chamber. It was taken into account that the ionizing particle interacts with the whole atoms, rather than with electrons. The problem was experimentally investigated for the case of argon–acetylene mixtures of varying concentration, using a ^{235}U target exposed in the thermal column of a reactor as the fission-fragment source. The results indicated that the amplitude of the ionization pulses increases with increasing tension, until a saturation level is reached. This may be due to the fact that the ionization potential of acetylene is lower than and very close to the excitation energy of the metastable levels of argon. Choice of a suitable gas mixture could reduce the ionization defect and increase the precision of the measurement of the energy of heavy, charged particles by the ionization method. (TTT)

10615 PRINCIPLES CONCERNING THE EVALUATION OF GAMMA SPECTRA. Viragh, Elemer; Vodros, Daniel. Magyar Kem. Lapja, 21: 653-61(Dec. 1966). (In Hungarian).

The gamma spectra of several radiation sources were investigated using a single channel scintillation counter. The parameters affecting the shape of spectrum curves were analyzed with a view to practical requirements and the factors responsible for the peaks were evaluated. Using some characteristic gamma spectra as examples, the probabilities of the appearance of photo peaks, Compton continua, escape peaks, reflexion peaks, overall peaks, etc., are pointed out. Besides qualitative interpretation, some quantitative correlations are suggested, on the basis of which the activity of the source can be determined. A method for the reduction of spectra to their components is presented. The dimension of the NaI/Tl crystal used was 1.5 by 2 in. (auth)

10616 DEVELOPMENT AND PERFORMANCE OF A PROTOTYPE SHADOW-SHIELD WHOLE BODY MONITOR. Boddy, K. (Scottish Research Reactor Centre, East Kilbride). Phys. Med. Biol., 12: 43-50(Jan. 1967).

A shadow-shield whole body monitor was developed which is capable of high sensitivity at low cost and which is of suitable design for incorporation in a mobile laboratory. The stages of development and the performance of the final prototype are described so that the shielding requirements and crystal volume can be estimated approximately for a required sensitivity. The prototype, using a 3 in. diameter × 3 in. high sodium iodide detector, has a sensitivity, or minimum detectable activity for iron-59 and cobalt-58 of approximately 4×10^{-3} μC. With a detector 11½ in. diameter × 4 in. it is shown that sensitivities comparable with steel-room monitors can be expected. The variation in counting-rate due to redistribution of the isotope in the patient's body was examined. (auth)

10617 MULTIPLICATIVE MUON EFFECT IN LEAD–IRON ABSORBER. Firkowski, Ryszard; Hibner, Juliusz; Stefanski, Wlodzimierz (Inst. of Nuclear Research, Polish Academy of Sciences, Lodz). Nukleonika, 11: 629-34(1966).

The design and performance of an experimental apparatus consisting of lead and iron absorbers and a set of detectors, each consisting of 5 G-M counters is given. This arrangement is used for the detection of the meson (μ) component of extensive air showers. It is calculated that for the Łódź Experimental Arrangement (detector width 17 cm) the probability of an incident meson (μ) together with at least one secondary particle produced in the absorber hitting 2 detectors is 0.029 while the probability of their hitting three such detectors is of the order of 0.001, and hence is negligible. (J.F.P.)

10618 SIMPLE AND ACCURATE METHOD OF CALIBRATION BY PHOTOPEAK EFFICIENCIES. Hutchinson, J. M. R.; Walker, D. H. (National Bureau of Standards, Washington, D. C.). Int. J. Appl. Radiat. Isotop., 18: 86-9(Jan. 1967).

A number of experiments have utilized the Gaussian approximation for fitting photopeak shapes in NaI (Tl) pulse-height distributions. This method is applied to some problems of radioactive source calibration, and results are compared with those based on a non-Gaussian approximation. The method is simple, but accurate, and allows the use of published tables without extensive numerical analysis. The major problem referred to is the uncertainty in the definition of the shape of the peak at points on the energy scale far away from the center. Uncertainties are compounded in nuclides such as ^{60}Co, ^{46}Sc, and ^{94}Nb, which have partially unresolved gamma rays, because of the necessity to estimate the contribution of one peak to another. Another source of error is associated with the Compton background from higher energy gamma radiation. (UK)

10619 NEW SCINTILLATOR FOR LIQUID SCINTILLATION COUNTING. Scales, B. (Imperial Chemical Industries Ltd., Alderley Park, Eng.). Int. J. Appl. Radiat. Isotop., 18: 1-6(Jan. 1967).

The results of investigations carried out with a new scintillator: 2-(4′-t-butylphenyl)-5-(4″-biphenyl)-1,3,4-oxadiazole (Butyl-PBD) are reported. Counting efficiencies and background counts of variously quenched toluene and dioxane systems containing Butyl-PBD were compared with similar systems containing PPO and DM-POPOP as the primary and secondary scintillators. Results suggest that Butyl-PBP is an advantageous replacement for the more conventional PPO-DM-POPOP systems, especially with quenched samples. (auth)

10620 INVESTIGATION OF LIGHT DISTRIBUTION FROM SCINTILLATIONS IN A GAMMA CAMERA CRYSTAL. Scringer, J. W.; Baker, R. G. (Univ. of Toronto, Ontario Cancer Inst., Toronto). Phys. Med. Biol., 12: 101-3(Jan. 1967).

In order to investigate a scintillation camera system analytically it is necessary to determine the distribution of light in the plane of the photocathodes from scintillation within the crystal. The relative responses of the photomultipliers may then be predicted, as a function of scintillation position, in terms of the light falling upon the photocathodes. Experimental arrangements used to measure the light distribution are described. It is concluded that scintillation within the crystal gives rise to isotropic light distribution in the plane of the detectors. This is of considerable importance in theoretical investigations of the camera, since the signal from each detector can then be directly related to the solid angle which the detector subtends at any scintillation position. Tables of solid angles may be used to predict phototube

responses to any scintillation for a known camera geometry. (UK)

10621 THE B.1N NEEDLE GEIGER–MUELLER COUNTER OPERATED IN THE CURRENT MODE. Kemplay, J. R. (Postgraduate Medical School, London). Phys. Med. Biol., 12: 99-100(Jan. 1967).

A Geiger-Müller counter is usually connected to a high resistance input circuit such as a cathode follower or compounded emitter follower. If this procedure is adopted for a B.1N needle counter (20th Century Electronics Ltd.) the cathode or emitter follower would need to be very close to the counter (not more than 18 inches) if the counter is to benefit from the high input resistance and low input capacitance of this type of circuit. Introducing such a circuit into the counter lead is inconvenient because of the circuit's physical size and the requirement for further leads to supply voltage for the valve or transistors. Extension of the counter lead to the main amplifier causes a reduction in signal amplitude resulting from the capacity of the additional lead. An alternative procedure is to use the counter in the current mode by taking the signal from the counter cathode to a low resistance input circuit. A suitable circuit for use with the needle counter operated in this manner is shown. (UK)

10622 AN INVESTIGATION OF THE PARAMETERS IN SCINTILLATION CAMERA DESIGN. Baker, R. G.; Scrimger, J. W. (Univ. of Toronto, Ontario Cancer Inst., Toronto). Phys. Med. Biol., 12: 51-63(Jan. 1967).

A theoretical approach to the design of an optimum gamma camera system was made by a mathematical formulation describing the operation of the system. The parameters considered as variables were the light guide thickness, the geometric array of photodetectors, the photocathode diameter, the phototube gain and the signal fractions inserted into the signal mixing network. Parameters which optimize the performance relative to transfer efficiency, image linearity and spatial resolution were determined. It was found that an optimum light guide thickness is approximately equal to one-half the tube separation distance (i.e., the radius of the detector phototube for the close-packed case). Peripheral tubes in the array must have increased gains relative to those in the center. The optimum signal fractions agree well with those obtained by others using an empirical approach. The spatial resolution estimates are not widely different from those observed in systems already developed. This analysis indicates that the empirically developed systems now in routine use are near optimal and no dramatic improvements may be expected from further developments using presently available components. (auth)

10623 AN INVESTIGATION INTO THE USEFULNESS OF FIGURE OF MERIT AS A CRITERION OF A COLLIMATING SYSTEM. Simons, H. A. B.; Bailey, J. M. (Royal Free Hospital School of Medicine, London). Phys. Med. Biol., 12: 29-41(Jan. 1967).

A figure of merit of a collimating system was proposed by Dewey and Sinclair to describe the ability of a detecting system to distinguish a region containing a different concentration of a gamma emitting isotope from that of its surroundings. It is shown that the value of the figure of merit can be calculated for simple collimating systems, and plane targets consisting of circles of uniform radioactivity, in terms of non-dimensional parameters and the intrinsic detection efficiency of the scintillation crystal. Results are given of experimental investigations of the figures of merit for various collimating systems and targets of different radii, which agree with the theory developed. It is shown that the figure of merit is insufficient to enable a choice to be made of the collimating system that will give the best spatial resolution of the structure of the target, and merely indicates the system that will best show the presence of the target. (auth)

10624 ANALYSIS OF GAMMA-RAY SPECTRA FROM NaI(Tl) AND Ge(Li) SPECTROMETERS. COMPUTER PROGRAMS. Helmer, R. G.; Heath, R. L.; Schmittroth, L. A.; Jayne, G. A.; Wagner, L. M. (Phillips Petroleum Co., Idaho Falls, Idaho). Nucl. Instrum. Methods, 47: 305-19(1967).

Descriptions are given of two computer programs that are used in the analysis of gamma-ray spectra from NaI(Tl) scintillation spectrometers. The programs can be used to determine the contributions to an experimental spectrum from either a set of isotopes or a set of monoenergetic gamma rays. In the former case, both the intensities and gains of the components can be varied to obtain the best fit. In the latter case both the intensities and energies can be varied. Examples of fits to experimental spectra are presented for both NaI(Tl) and Ge(Li) spectrometers. (auth)

10625 METHOD FOR GENERATING SINGLE GAMMA-RAY SHAPES FOR THE ANALYSIS OF SPECTRA. Heath, R. L.; Helmer, R.; Schmittroth, L. A.; Cazier, G. A. (Phillips Petroleum Co., Idaho Falls, Idaho). Nucl. Instrum. Methods, 47: 281-304(1967).

A method is described for the calculation of pulse-height distributions which represent the response of a NaI scintillation spectrometer to monoenergetic photons. The method is based upon an interpolation between experimental spectra for sources emitting only one gamma ray. A description of the experimental procedures used to accumulate input data is given. This discussion includes the analysis of photopeak shapes, detector efficiency, and the nonlinear relationship between energy and pulse-height for NaI. The interpolation method is described. To illustrate the quality of the resulting calculated gamma-ray shapes, they are compared with input and other simple spectra. The application of this method to spectra obtained with germanium detectors is discussed. (auth)

10626 NEW METHOD FOR MEASURING THE PARTICLE ENERGY ACCORDING TO THE DIAMETERS OF THE HOLES IN SOLID STATE NUCLEAR TRACK DETECTORS. Somogyi, Gyoergy. ATOMKI (At. Kut. Intez.) Kozlem., 8: 218-24(Sept. 1966).

Quantitative results are given on the energy sensitivity of cellulose nitrate used as an alpha particle track detector. It was found that an energy resolution of about 0.5 to 1 MeV can be achieved in the energy region 1 to 7 MeV, between etching times of 1 and 3 hrs when using 20% NaOH at 50°C. (J.F.P.)

10627 VACUUM CHAMBER FOR INVESTIGATIONS OF NUCLEAR REACTIONS. Schlenk, Balint; Papp, Istvan; Mesko, Laszlo. ATOMKI (At. Kut. Intez.) Kozlem., 8: 232-6(Sept. 1966). (In Hungarian).

The vacuum chamber described below is suitable for many-sided experimental investigations of nuclear reactions emitting charged particles. The target is placed in the center of the vacuum chamber and by the aid of solid state detector rotating around the target angular distribution measurements of good energy resolution can be performed. At angles 45, 90, and 135° with respect to the beam three scintillation counters are mounted in the chamber, which can be used for monitor and coincidence purposes. (auth)

10628 DELAYED COINCIDENCE LINE SHAPES FROM A SCINTILLATION DETECTOR WITH WIDE DYNAMIC RANGE. Lefevre, H. W.; Binney, J. L. (Univ. of Oregon, Eugene). Nucl. Instrum. Methods, 47: 255-9(1967). (RLO–1921-10).

Timing uncertainties which originate in the electron transit time spread in a photomultiplier tube are calculated under the assumption that errors vary inversely with the square root of the number of photoelectrons produced by a scintillation. Delayed coincidence line shapes are calculated for a uniform pulse height distribution and for the pulse height distribution which results from elastic scattering of monoenergetic neutrons in an organic scintillator. No detection threshold is imposed but in each case the analysis may be easily modified to incorporate one. The line shapes which result are not markedly wider than the Gaussian distribution which would result from accepting only spectrum cutoff size pulses for timing. The line shapes are also independent of spectrum cutoff and scale with this gaussian distribution. Several characteristic properties of these resolution functions are discussed. (auth)

10629 VARIANCE REDUCTION IN THE MONTE CARLO METHOD FOR DETERMINING THE VOLUME OF MULTIDIMENSIONAL NONANALYTIC SOLIDS. Hague, J. F. (London Univ.). Nucl. Instrum. Methods, 47: 194-200(1967).

A Monte Carlo method for finding the volume of any definable object located within a unit cube is considered. The method, which does not require the surface of the solid to be described by an explicit function, is developed into suitable program form and s tested for cylinders, spheres, and pyramids in 2, 4, and 6 dimensions. Variance reduction factors, over unmodified Monte Carlo, of up to 30 for a 6 dimensional cylinder, and 3 for a 6 dimensional pyramid are obtained. An example is given of the application of the method to high energy particle physics. (auth)

10630 FAST NEUTRON FLUX MEASUREMENT BY MEANS OF PLASTICS. Medveczky, Laszlo; Somogyi, Gyoergy. ATOMKI (At. Kut. Intez.) Kozlem., 8: 226-31(Sept. 1966).

An attempt was made to detect fast neutrons by means of nuclear reactions occurring in cellulose nitrate sandwiches exposed to 14-MeV neutrons. Also a means of increasing the efficiency of these detectors by using suitable but not fissile cover materials was investigated. It was established that the plastics can be applied as simple and useful detectors for measuring the fast neutron flux. (J.F.P.)

10631 GERMANIUM p–i–n DETECTOR. Ryndina, E. Z.; Uhrin, Janos. ATOMKI (At. Kut. Intez.) Kozlem., 8: 238-43 (Sept. 1966). (In Russian).

A detector of 3-mm sensitive layer and 1.9-cm^2 surface was made. Spectra of ^{203}Hg, ^{137}Cs, ^{60}Co, ^{151}Gd, and ^{153}Gd are presented. In the case of ^{60}Co the resolution is 5.5 keV. (auth)

10632 TRIGGER-CIRCUIT FOR BETA-RAY SPECTROMETERS WITH SEMICONDUCTOR DETECTORS IN STACK-ASSEMBLIES. Allkofer, O. C.; Fox, J. M.; Grupen, C. (Univ., Kiel). Nucl. Instrum. Methods, 47: 342-4(1967).

When taking beta-ray spectra by semiconductor detector techniques it is of advantage to stack several detectors in series. The resolution of a single detector determines the optimum resolution of the stack-assembly. However, such a system involves also the possibility of spurious counts. These edge effects cause an additional deterioration of the resolution. To take best out of the resolution of the detectors a trigger-circuit was developed to exclude the spurious pulses from entering the pulse-height analyzer. A coincidence-anticoincidence-circuit discriminates against the unwanted pulses. The pulses so selected are fed to the input gate of the pulse height analyzer. In this way the resolution of the spectrometer is improved. Moreover, the background counts are reduced to a minimum value. This is of importance when analyzing sources of low activities. (auth)

10633 A BROAD RANGE MAGNETIC PAIR SPECTROMETER FOR GAMMA RAYS OF ENERGY 5 TO 50 MeV. Leslie, J. R.; Main, I. G. (Univ. of Liverpool). Nucl. Instrum. Methods, 47: 345-52(1967).

A 180° focusing pair spectrometer was developed in which the use of triggered sonic spark chambers in the focal plane allows the measurement of a broad range (approximately 20 MeV/c) of values of the total electron pair momentum at a given magnetic field setting. Efficiency calculations give the ratio of spectral width (at half maximum efficiency) to momentum at peak efficiency as 0.70. The instrument described was used to measure spectra of gamma rays resulting from proton capture into the giant resonance region of nuclear excitation. An energy resolution of 3% fwhm was obtained, combined with an overall calculated efficiency per gamma ray of approximately 0.4%. The background from competing processes of higher probability, characteristic of an energy absorption spectrometer, is totally absent. (auth)

10634 DIGITIZED WIDE-GAP WIRE SPARK CHAMBER. Chikovani, G. E.; Laverriere, G. C.; Schuebelin, P. (CERN, Geneva). Nucl. Instrum. Methods, 47: 273-6(1967).

A possibility for digitizing a wide-gap spark chamber by means of magnetostriction is presented. The high-tension central electrode consists of two perpendicular information planes; two other information planes are grounded. A special system is designed for the read-out of the high-tension electrodes. The problem of reducing memory and recovery time was studied. Henogal with admixture of 5% of argon and 6×10^{-3}% of freon as quencher gave a memory time of ~1 μsec and a recovery time smaller than 5 msec. The properties were studied on a model of $40 \times 40 \times 20$ cm^3, and chambers of $150 \times 150 \times 20$ cm^3 were constructed. (auth)

10635 PROPORTIONAL COUNTER FOR LOW-ENERGY γ RADIATION. Kroy, Walter; von Egidy, Till (Technische Hochschule, Munich). Nukleonik, 8: 435-8(Nov. 1966). (In German).

The construction and characteristics of a proportional counter for measurement of γ radiation in the region from 1 to 50 keV are described. By an anticoincidence arrangement it was possible to reduce the background from β radiation and high-energy radiation by a factor of 10. At the same time the energy resolution possibilities were improved considerably in comparison with the usual counters. (tr-auth)

10636 A Ge(Li)-SPECTROMETER WITH PLASTIC ANTICOINCIDENCE MANTLE FOR GAMMA ANALYSIS OF FUEL ELEMENTS. Hasselgren, Arne (Chalmers Univ. of Technology, Goteborg). Nukleonik, 8: 443-6(Nov. 1966).

A lithium drifted germanium detector 5 mm × 4.0 cm^2 was used in anticoincidence with a 24 cm diameter by 31 cm long NE 102A plastic scintillator for measuring gamma radiation from reactor fuel elements. The spectrometer reduces and smooths the Compton distribution and is a cheap and simple instrument for simplifying the response function of a Ge(Li)-detector. (auth)

10637 ELECTRONICS IN NUCLEAR MEASUREMENTS. PART II. Price, L. W. (Cambridge Univ., Eng.). Lab. Pract., 16: 42-8(Jan. 1967).

Various methods of reducing the background count and also electronic circuits used in proportional counting equipment are described. (auth)

10638 FAST NEUTRON SPECTROSCOPY BY PROTON-RECOIL PROPORTIONAL COUNTING. Bennett, E. F. (Argonne National Lab., Ill.). Nucl. Sci. Eng., 27: 16-27(Jan. 1967).

Small proportional counters containing hydrogen and without collimation were used to measure reactor-neutron spectra with a resolution that is adequate for comparison with existing energy-group methods of calculation over the energy range from 1 keV to 1 MeV. The counters are efficient and operate satisfactorily at low (10^5/cm^2 sec) flux levels. Experimental methods currently in use for in-core measurements using proportional counters vary; the one described here makes use of an electronic pulse-shape discrimination to eliminate the background of gamma radiation. The nature of the numerical procedure required to extract neutron spectra from measured energy distributions of recoil protons bears upon the resolution and statistical precision of the result. Examples of measured neutron spectra are given where they illustrate the various points of experimental technique. (auth)

10639 THE USE OF INTERMEDIATE MICROPHOTOGRAPHY IN THE DETECTION OF DALITZ PAIR ORIGINS. Cohen, J. J.; Friedlaender, E. M.; Visky, T. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 11: 449-503(1966).

A simple method is proposed for achieving high accuracy in the detection of Dalitz pair origins or similar events in nuclear emulsions. The sensitivity to noise of the high precision microscopes is obviated by means of an intermediate microphotograph measurable with more rugged equipment. Preliminary experimental results are presented. (auth)

10640 HIGH-TEMPERATURE IONIZATION CHAMBER FOR DETECTING LOW-LEVEL PLUTONIUM CONTAMINATION. Watts, Richard J. (Los Alamos Scientific Lab., N. Mex.). Nucl. Appl., 2: 320-4(Aug. 1966). (LA-DC-7557).

A high-temperature ionization chamber for the investigation of the penetration of containers by molten plutonium has been developed. At 1000°C it is capable of detecting 0.1 μg of Pu alloy which has diffused through the grain boundaries to the surface of a tantalum container. (auth)

10641 ACTIVATION OF GOLD SPHERES AND FOILS IN NONISOTROPIC NEUTRON INCIDENCE. Helm, F. H. (Argonne National Lab., Ill.). Nucl. Appl., 2: 325-34(Aug. 1966).

Gold spheres and foils were activated in a nonisotropic neutron flux in the center of boxes that were cadmium-lined on five sides and located in the graphite thermal column of the JUGGERNAUT reactor. The boxes were cubes, 5, 10, and 20 cm on a side and were either left void or filled with graphite. In the sphere measurements, an attempt was made to measure the angular flux distribution by scanning the spatial distribution of the activation over 1-cm-diam spheres. The results were compared to calculated values. Resolution curves were calculated for gold spheres of different diameters. The self shielding of 1-cm^2 gold foils was measured for two different foil orientations and for foil thicknesses between 0.0013 and 0.05 cm. The self shielding was also calculated, approximating the angular flux distribution by polynomials and by step functions in the cosine of the angle of incidence. Finally, a qualitative method was developed to determine the angular flux distribution from the results of the self-shielding measurements with foils. (auth)

10642 LONG-TERM AND THE ALTITUDE DEPENDENCE OF THE BAROMETRIC COEFFICIENT FOR NEUTRON MONITORS. Lockwood, J. A.; Kaplan, Jordan (Univ. of New Hampshire, Durham). J. Geophys. Res., 72: 431-5(Jan. 1, 1967).

An equation to express the relationship between variations in neutron monitors and barometric pressure is given. Yearly average barometric coefficients are plotted and tabulated for Mt. Washington and Durham monitors. (J.H.M.)

10643 DIRECT OBSERVATION OF SEMICONDUCTOR DETECTORS CURRENT PULSES. Vacher, J. (CEN, Grenoble, France). Bull. Inform. Sci. Tech. (Paris), No. 108, 89-97(Oct. 1966). (In French).

A device is described which permits the observation of the form of current pulses produced, in semiconductor-detectors, by the α particles of UO_2 which renders the junction sensitive to neutrons. Due to the rapidity of these pulses a sampling oscilloscope must be used. The amplitude of the pulses to be observed is however smaller than the noise amplitude of obtainable oscilloscopes. To eliminate this noise, series of circuits were constructed which restore the mean value of the samples in numerical form. These samples are then fed to a multichannel analyzer used as a multiscaler which reconstructs the form of the pulses point by point. (auth)

10644 IMPROVED TECHNIQUE FOR TRACK PROFILE MEASUREMENT IN NUCLEAR EMULSIONS. Hall, J. E.; Zaffarano, D. J. (Ames Lab., Iowa). Contract W-7405-eng-82. Nucl. Instrum. Methods, 48: 141-6(Feb. 11, 1967). (IS-1382).

A microdensitometer utilizing a signal averaging digital computer was developed to discriminate between the charges of particles producing short tracks in nuclear emulsions. For each track the photoelectric profiles of ten track segments, each 5.0 μm long, were averaged and the result plotted, yielding a mean

profile curve. Results of measurements made on tracks produced by known particles of charges 1, 2 and 3 are presented. The normalized area of the profile curve was found to give the best charge separation. Measured photometric mean track width values were corrected for the depth of the tracks in the emulsion. The charge groups were completely separated by measurement of 50 μm of each track, requiring less than 15 min per track. (auth)

10645 IMPROVED IONIZATION COUNTER RESOLUTION WITH FET PREAMPLIFIER. Moon, L. L. (Univ. of California, Livermore). Contract W-7405-eng-48. Nucl. Instrum. Methods, 48: 162(Feb. 11, 1967). (UCRL-70081).

The use of low noise, charge sensitive FET input preamplifiers with gridded ionization chambers, in order to improve chamber resolution, was investigated. It was found that at room temperature the rms equivalent noise was 115 electrons and with the ionization chamber connected the noise increased to 188 electrons. Noise reduction was found to be possible by cooling the FET. Better resolution was also found by using 90% argon–10% methane mixtures in the ionization chamber. (B.G.D.)

10646 RECENT PERFORMANCE OF A GAS-IMAGE AMPLIFYING DETECTOR OPERATING IN THE SPARK REGION. Roux, G.; Lansiart, A.; Morucci, J. P. (CEN, Saclay, France). Nucl. Instrum. Methods, 48: 167-9(Feb. 11, 1967). (In French).

A special spark chamber for the detection of gamma- and x-ray emitters is studied. Characteristics of the detector, such as lifetime, dead time, and counting rate, which were essentially limited by the energy lost in the sparks, are discussed. The lessening of this energy loss is systematically studied for a detector having a diameter of 20 cm, length of spark space of 4 mm, and effective capacity of spark space of 140 pF, which is filled with gas. A schematic diagram is given for the detector and associated electronic circuits. Also the variation of the counting rate as a function of anode grid voltage is discussed. (J.F.P.)

10647 MODIFIED CASCODE PREAMPLIFIER FOR PROPORTIONAL COUNTERS. Bennett, E. F. (Argonne National Lab., Ill.). Nucl. Instrum. Methods, 48: 170-2(Feb. 11, 1967).

A preamplifier, utilizing a modified cascode circuit, for use with a proton-recoil proportional counter is described. (B.G.D.)

10648 THE MEASUREMENT OF MULTIPLE SCATTERING, OF TRACK DIRECTION AND POSITION IN SPARK CHAMBERS. Pinkau, K. (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger.). Nucl. Instrum. Methods, 48: 173-4(Feb. 11, 1967).

The problem of multiple scattering in spark chambers has been considered recently (Z. Phyzik 193: 163(1966)). The results obtained are applied to the problems of measuring the particle's energy, and its most probable position and angle of incidence on a spark chamber if multiple scattering in the plates of the chamber cannot be neglected. (B.G.D.)

10649 CONTROL OF LITHIUM DRIFT CURRENT IN SILICON AND GERMANIUM. Harpster, J. W. (Ohio State Univ., Columbus). Nucl. Instrum. Methods, 48: 175-6(Feb. 11, 1967).

The application of commercially available instrumentation for controlling drift current in silicon and germanium by regulating the semiconductor temperature is described. (B.G.D.)

10650 DEVELOPMENT OF FERRITE CORE READOUT ON THE PULSED ELECTRODE OF WIRE PLANES. Blieden, R. (Brookhaven National Lab., Upton, N. Y.); Menes, J.; Turkot, F.; Anderson, E. W.; Bleser, E.; Collins, G.; Edelstein, R.; Hien, N.; McMahon, T. Nucl. Instrum. Methods, 48: 177-8(Feb. 11, 1967). (BNL-10695).

Results are presented which indicate that ferrite-core readout of the pulsed electrode of wire planes is well suited to the requirements of on-line high energy (5–30 GeV/c) scattering experiments. (B.G.D.)

10651 CHERENKOV COUNTER WITH LARGE DETECTION SURFACE. Banaigs, J.; Berger, J.; Goldzahl, L.; Mouellic, B. (CEN, Saclay, Gif-sur-Yvette, France). Nucl. Instrum. Methods, 48: 64-70(Feb. 11, 1967). (In French).

The design and construction of a gas Čerenkov-counter of one m^2 cross-sectional area and operating at pressures of up to 8 bar is described. The light collection is effected by multiple reflection on diffusely reflecting surfaces. Measurements of the detection efficiency show the counter to be 98% efficient for pions of 3.5 GeV/c. The results obtained indicate that the construction of considerably larger detectors of this kind can be envisaged. (auth)

10652 COMPUTER TRACK MATCHING IN BUBBLE CHAMBERS. Grosso, C.; Rinaudo, G.; Werbrouck, A. E. (Istituto Nazionale di Fisica Nucleare, Turin. Univ., Turin). Nucl. Instrum. Methods, 48: 71-6(Feb. 11, 1967).

A computer program is described for coupling the measurements of bubble chamber tracks in three stereoscopic views by the parameter reconstruction method. The procedure was applied to the six emitted prongs of over 1000 interactions of 5 GeV/c π^+ in the British National HBC. Accuracy of the method is indicated by the observation that if any of these events have the three corresponding track measurements interchanged, the subsequent helix reconstruction by THRESH has failed to reveal an inconsistency. FSD pre-measurements can be combined similarly. Other possible uses of parameter reconstruction are discussed, such as one view measurements of delta ray energies, and reconstruction of high curvature electrons in heavy liquids. (auth)

10653 DETEC, A SUBPROGRAM FOR SIMULATION OF THE FAST-NEUTRON DETECTION PROCESS IN A HYDRO-CARBONOUS PLASTIC SCINTILLATOR. Gustafsson, B.; Aspelund, O. (Aktiebolaget Atomenergi, Studsvik, Sweden). Nucl. Instrum. Methods, 48: 77-86(Feb. 11, 1967).

A description is given of the subprogram DETEC, which for energies below 5 MeV simulates the detection process of a fast-neutron within a large cylindrical plastic scintillator. DETEC has been coded in FORTRAN IV, and consists of a subroutine and a BLOCK-DATA subprogram. The latter is in its present form adapted to the dimensions 5 cm dia. × 8 cm of the scintillating materials NE102 and NE102A. The character of DETEC as a subprogram is manifest through the requirement of a main routine for generation of the following input parameters (all, except for the last one, referred to the detector surface) of the fast-neutron: position; direction; energy; entrance time; input weight and the discriminator threshold. When these are provided, the virtues of DETEC are recording of the detected weight and the time elapsed prior to the detection event. The merits of DETEC are finally demonstrated in two typical applications. (auth)

10654 DETECTION EFFICIENCY OF PLASTIC SCINTILLATION COUNTERS FOR NEUTRONS IN THE ENERGY RANGE 20 TO 130 MeV. Crabb, D. G. (Univ. of Southampton, Eng.); McEwen, J. G.; Auld, E. G.; Langsford, A. Nucl. Instrum. Methods, 48: 87-92(Feb. 11, 1967).

Measurements on plastic scintillation counters of 28.6 cm thickness and 30 cm dia. were made with neutrons of energies 20–130 MeV. The detection efficiency was measured in detail for different parts of the counter and integrated to give the overall efficiency as a function of energy. The results are compared with calculations based on the work of Kurz and are found to be consistent with them. (auth)

10655 DETERMINATION OF FISSION FRAGMENT ENERGIES USING SOLID-STATE DETECTORS. Forgue, V.; Kahn, S. (Aerojet-General Nucleonics, San Ramon, Calif.). Nucl. Instrum. Methods, 48: 93-102(Feb. 11, 1967).

A method of correcting for the pulse height defect of fission fragments in silicon surface barrier detectors is described. Loss of energy in the gold window and by elastic collisions in the silicon are considered as well as loss of pulse height from incomplete charge collection in the detector. The method gives identical results for the degraded energies of fission fragments passing through a given amount of gas when the total defects of the detectors used differ by 15 MeV. (auth)

10656 TRAPPING IN DEFECT STATES AS A SOURCE OF THE PULSE HEIGHT DEFECT IN SILICON SURFACE BARRIER DETECTORS. Eisler, P. L. (Div. of Mineral Chemistry, Port Melbourne, Australia). Nucl. Instrum. Methods, 48: 103-8 (Feb. 11, 1967).

The evidence from charge collection efficiency measurements is considered in the light of the various processes which limit the speed of transient response in silicon surface barrier detectors. This establishes that trapping is predominantly responsible for the apparent inefficiency of the charge collection process. A method of measuring the energy difference between a trapping level and the edge of the appropriate vacant energy band was devised in terms of a simple theoretical model. In the case of a detector for which this model was suitably accurate, this energy difference was 0.23 eV. (auth)

10657 A PARTICLE IDENTIFICATION SYSTEM FOR USE WITH 30 MeV ^{3}He PARTICLES. Broadhurst, J. H.; Pyle, G. J. B. (Univ. of Birmingham, Eng.). Nucl. Instrum. Methods, 48: 117-24(Feb. 11, 1967).

A particle identification system is described which is based on a fast multiplication of signals proportional to dE/dx and E from a silicon surface barrier counter telescope. This system is compared with others already in use which generate a similar product for particle identification. The performance of the system for identification of ^{3}He and α-particles in the 10 to 40 MeV energy region is shown as an illustration of the capability of the system. (auth)

10658 REMARKS ON THE METHOD OF EFFECTIVE COUNTS FOR COMBINING EXPERIMENTAL RESULTS. Sandor,

T. (Louisana State Univ., Baton Rouge). Nucl. Instrum. Methods, 48: 131-2(Feb. 11, 1967).

It was shown with the help of the maximum likelihood principle that the method of effective counts which was suggested on the combination of counting rates showing Poisson fluctuations only cannot be applied when the counting rates depend on additional parameters apart from the Poisson fluctuation. The combination of data in such a case has to be done in the same way as prescribed by the method of least squares. (auth)

10659 IONIZATION FLUCTUATIONS AND RESOLUTION OF IONIZATION CHAMBERS AND SEMICONDUCTOR DETECTORS. Alkhazov, G. D.; Komar, A. P.; Vorobev, A. A. (Ioffe Inst. of Physics and Tech., Leningrad). Nucl. Instrum. Methods, 48: 1-12(Feb. 11, 1967).

The Fano factor F determining the variance of ionization fluctuations is calculated by Fano's approximate method for a variety of gases and for Si and Ge. The calculated Fano-factor for He, Ne, Ar, He + 0.5% Ar; Ne + 0.5% Ar; Ar + 0.5% C_2H_2 equals to 0.17; 0.17; 0.17; 0.055; 0.05; 0.075 respectively. Ionization fluctuations in semiconductors are calculated using Shockley's and Hodgkinson's models of the ionization process in solids. Both models give fairly close results: $F_{Si} = 0.05 + 0.1$; $F_{Ge} = 0.1 - 0.2$. The Fano factor is measured for Ar and Ar – 0.5% C_2H_2 in a gridded ionization chamber. The fwhm (for $E_\alpha = 5.68$ MeV) is 13 keV; F_{exp} is 0.19 for Ar and ≤ 0.09 for Ar + 0.5% C_2H_2, being in good agreement with the calculations. The ultimate fwhm of gas ionization chambers may be 7 keV at an α-particle energy of $E_\alpha = 6$ MeV. The ultimate resolution of semiconductor γ- and β- detectors is about 1 keV at $E_{\beta,\gamma}$ = 600 keV, whereas that of semiconductor α-detectors is probably 5–6 keV. (auth)

10660 SEMICONDUCTOR DETECTOR AS A FAST NEUTRON SPECTROMETER. Miller, R. G.; Kavanagh, R. W. (California Inst. of Tech., Pasadena). Nucl. Instrum. Methods, 48: 13-27 (Feb. 11, 1967).

Silicon semiconductor detectors have been used to measure the energies of 6 to 17-MeV neutrons to a precision of 5 to 15 keV by utilizing (n,α) and (n,p) nuclear reactions in the active volumes of the detectors. Criteria for the selection and use of a detector are given. Various combinations of cross sections for the most important detection processes, $^{28}Si(n,\alpha)^{25}Mg$ and $^{28}Si(n,p)^{28}Al$, are presented for reactions leading to the first four states of both residual nuclei for neutron energies from 7.2 to 16.4 MeV, facilitating the use of the detector for determination of neutron flux. Resolution and pulse-height anomalies associated with the recoil ^{25}Mg and ^{28}Al ions are described. Methods of data analysis are discussed. (auth)

10661 HIGH TEMPERATURE BEHAVIOR AND LONG-TERM STABILITY OF LITHIUM DRIFTED SILICON SURFACE-BARRIER DETECTORS. Tuzzolino, A. J.; Perkins, M. A.; Kristoff, J. (Univ. of Chicago). Nucl. Instrum. Methods, 48: 33-41(Feb. 11, 1967).

Lithium-drifted silicon surface-barrier detectors were fabricated which exhibit stable electric and α-particle characteristics under conditions of prolonged aging and repeated exposure to thermal-vacuum environments. The detectors will operate at a temperature of 85°C and high vacuum for several days and at a temperature of 100°C and high vacuum for several hours, with no evidence of noise instability. The operating characteristics of such detectors were studied over a period of fourteen months. These studies included measurements of their electric and α-particle characteristics taken before, during and after extended thermal-vacuum testing at 50 and 85°C and short-term testing at 100°C. Degradation in electric and α-particle characteristics resulting from such testing and aging was found to be negligible over the fourteen month time period. The α-particle measurements at 100°C indicate that the fractional change in the mean energy per ion pair in going from room temperature to 100°C is approximately –1.8%. The results of these studies are reported. (auth)

10662 LIGHT PIPE FOR VERY THIN LARGE AREA SCINTILLATORS. Verondini, E. (Univ. of Bologna). Nucl. Instrum. Methods, 48: 42-4(Feb. 11, 1967).

Characteristics are given of a new type of light pipe particularly suitable for very thin plastic scintillators. The uniformity of the system is very good and the efficiency is everywhere equal to 1 with plastics down to a thickness of 20 μm. (auth)

10663 PROPORTIONAL COUNTER WITH LARGE THIN WINDOWS FOR LOW ENERGY α PARTICLES. Benn, J.; Mueller, H. H.; Staub, H. H.; Winkler, H. (Univ. of Zurich). Nucl. Instrum. Methods, 48: 56-60(Feb. 11, 1967).

The construction and performance of a proportional counter with large thin windows for detecting α particles with energies as low as 90 keV is described. (auth)

10664 GAS AMPLIFICATION IN PROPORTIONAL COUNTERS WITH ARGON AND NITROGEN. Zastawny, A.; Mizeraczyk, J. Nukleonika, 11: 685-90(1966). (In Russian).

Measurements of gas amplification in proportional counters with argon and nitrogen were taken, at pressures ranging from 298 to 581 mm Hg at 0°C. Good agreement was found between experimental data and a new formula for gas amplification in proportional counter. The possibility of an easy investigation method of some photoelectric effects in proportional counters is shown. (auth)

10665 CHECKING PERFORMANCE OF NUCLEONIC APPARATUS WITH SHORT-LIVED ISOTOPES. Marais, P. G.; Karsten, J. H. M.; van R. Smit, J. (Fruit and Food Tech. Research Inst., Stellenbosch, S. Afr.). S. Afr. J. Agr. Sci., 9: 491-4(1966).

Radioactive decay affords an excellent means of checking the performance of nucleonic apparatus, by taking successive measurements during the decay of an isotope, and comparing the observed counting rates with their expected relative ratios, calculated from the decay constant of the isotope used. To limit the duration of such tests, a short-lived isotope must be used and since some or all of the counting periods will be comparable to the half-life of the isotope, the mean observed counting rates have to be converted to instantaneous rates. The use of ^{137m}Ba for tests of this nature is described. This isotope was chosen because it can be separated easily and efficiently from ^{137}Cs, and its half-life is accurately known as 153.08 ± 0.004 sec. A halogen-quenched G-M counter with a resolving time (τ) of 379 ± 1 msec was used. A solution containing ^{137m}Ba was placed adjacent to the G-M counter, and the measurements commenced when the counting rate was 80,000 cpm. The results demonstrated that the true instantaneous counting rates at the various counting periods were linearly related to their corresponding theoretical ratios. It was therefore concluded that the value of τ was correct, and that the G-M counter performed correctly up to 80,000 cpm where 50% of the pulses were not recorded due to τ. A constant standard deviation could be obtained for all readings by simply increasing the counting periods during the decay of the source. This has the additional advantage of ensuring an even distribution of the experimental points with respect to the relative ratios of their counting rates. The use of short-lived isotopes as outlined here offers a rapid, critical, and valuable test for checking the performance of any nucleonic apparatus. It serves as an overall test since the detector is also used. Apart from checking whether τ has been correctly determined, direct information is obtained on the max counting rate that can be handled by such equipment. The conversion of mean to instantaneous rates can be carried out rapidly because tables containing correction factors are available. (BBB)

10666 LIQUID SCINTILLATION COUNTER TECHNIC. Langner, Peter (Packard Instruments, Inc., Downers Grove, Ill.). Z. Instrum., 74: 271-83(Sept. 1966). (In German).

Today liquid scintillation counting is the most widely used method for measurement of β emitters. The operation of a liquid scintillation spectrometer is reviewed. The scintillation process, quenching and its correction with methods of standardization, principles of spectrum and pulse height analysis, and a measurement method for double label experiments are presented. Characteristics of various scintillators, photomultiplier spectra, scintillation mechanism, solvents, emission spectra, spectrum shift, photon absorption, and quenching effect are discussed. Electronic measurement configurations and coupling between sample-scintillator mixtures and photocathode are illustrated. Linear amplification circuitry is diagrammed schematically. Practical spectrometry is discussed in terms of pulse height analysis, null effect, balance point, counting efficiency or sensitivity, standardization methods, such as internal standardization, channels ratio, and external standardization, concept and mechanism of a liquid scintillation counter, and measurement methods for double labeling. Statistical error theory, specialized counting techniques for scintillator mixtures suspensions, sample ashing, paper chromatography strips, and flow measurements are briefly discussed. (BBB)

10667 THERMOLUMINESCENT DOSIMETRY. Perry, K. E. (United Kingdom Atomic Energy Authority, Winfrith, Eng.). Nucl. Eng., 11: 875-7(Nov. 1966).

The applications of thermoluminescent materials in the measurement of radiation dose are reviewed. LiF has the advantages over CaF_2 of good energy response to gamma, ability to measure beta, comparative freedom from spurious light emission when used as a loose powder, and the very small volume of material required. Designs of reading instruments and their mode of operation are described. The use of an inert gas flow and preset temperature limits during measurement increase the accuracy of dose indication. (UK)

10668 NEW WINDOW FLOW PROPORTIONAL COUNTER FOR COUNTING RADIOACTIVE GAS-LIQUID PARTITION CHROMATOGRAPHY EFFLUENTS. Welch, Michael; Withnell, Ronald; Wolf, Alfred P. (Brookhaven National Lab., Upton, N. Y.). Anal. Chem., 39: 275-7(Feb. 1967).

A cylindrical window gas flow proportional counter, with improved dynamic efficiency and exceptionally stable and reproducible counter characteristics over long periods of counter use, was developed. Diagrams show the counter sectionally and along and perpendicular to the direction of gas flow. Efficiency characteristics of both "sandwich" and cylindrical counters are given using various window materials for ^{11}C and ^{14}C counting. The advantages of the cylindrical window flow counter are discussed. (D.H.M.)

10669 DESIGN OF MAGNETIC SPECTROMETER FOR PARTICLES WITH MOMENTUM UP TO 400 MeV/c. Afanasev, N. G.; Goldshtein, V. A.; Savitskii, G. A.; Khvastunov, V. M.; Shevchenko, N. G. Ukr. Fiz. Zh., 11: 1146-8(Oct. 1966). (In Ukrainian).

A description is given of an electron-optic spectrometer for measuring up to 400-MeV/c particles at a magnetic field intensity of ~10.5 kOe. Results of spectrometer measurements of α particles of ^{210}Po are in good agreement with the calculations. (R.V.J.)

10670 LUMINESCENCE OF SODIUM IODIDE ACTIVATED BY EUROPIUM. Vaidanich, V. I.; Lyskovich, A. B.; Tsyupka, P. M. Ukr. Fiz. Zh., 11: 1154-6(Oct. 1966). (In Ukrainian).

Results are given of the investigation of the photoluminescence of NaI(Eu) crystals. Experiments were carried out with monocrystals prepared by the Stockbarger method. The absorption spectra of NaI(Eu) with europium concentration of 0.005 wt % at room temperature is included, as well as temperature dependence of the spectrum of photoluminescence of the NaI(Eu) crystal with activator concentration of 0.05 wt %. (R.V.J.)

10671 THE FIRST GERMAN DEMOCRATIC REPUBLIC SPECTROMETER FOR MEASURING HUMAN RADIATION. Poulheim, K. (State Center for Ionizing Radiation Protection, Berlin). At. Energ. (USSR), 21: 311-12(Oct. 1966). (In Russian).

The design and performance of a scintillation spectrometer with a NaI(Tl) crystal used for measuring the natural potassium and ^{137}Cs content in human organisms are discussed. The background spectrum of human emission was measured with 125 × 100 mm crystals and the coefficient of γ attenuation was tabulated at energies ranging from 0.090 to 3 MeV. The integral background is 0.71 pulse/min. cm^3. (R.V.J.)

10672 SCINTILLATION RESPONSE OF A NaI(Tl) CRYSTAL TO POSITRONS. Tomimasu, Takio; Sugiyama, Suguru (Electrotechnical Lab., Tokyo). Oyo Butsuri, 35: 730-4(Oct. 1966). (In Japanese).

A scintillation response of a NaI(Tl) crystal to positrons was studied using a two-crystal NaI(Tl) scintillation spectrometer. The scintillation response of the crystal to positron-electron pairs induced by gamma rays in the crystal was accurately measured. To make clear the difference in responses to positrons and to electrons, gamma spectra were also measured by use of the same device, and the response to electrons was obtained. The scintillation response to positrons was evaluated from the experimental response to positron-electron pairs and to electrons with the aid of theoretical positron spectra in the crystal. The response to positrons is larger by about 4% that to electrons at 100 keV. The difference in scintillation response is negligibly small at energies above 0.5 MeV. (NSA of Japan)

10673 STUDY OF THE REGISTRATION OF FISSION-FRAGMENT TRAJECTORIES IN SOME SOLID INSULATING SUBSTANCES. Maurette, Michel (Faculte des Sciences de Paris, Orsay, France). J. Phys. (Paris), 27: 505-12(Sept.-Oct. 1966). (In French).

The results are presented of an optical microscope study of the recorded trajectories of fission fragments slowed down by air and revealed as tracks by chemical etching in mica, olivine, and a plastic material (makrofol). After having observed that for fragment energy less than a high critical value the tracks do not form in any of these solids, it is concluded that in mica they could be produced neither by the Brinkman process nor the thermal-spike process and that the mechanisms responsible for the formation of the tracks in mica and makrofol are probably different. (auth)

10674 DEVICE FOR MEASURING AND/OR INDICATING RADIATION INTENSITY. Guyenot, Ernest; Hahn, Eberhard. Czech Patent 5971-60.

A device is described for measuring/and or indicating radiation intensity for equipment operating with corpuscular radiation, in particular for electron microscopes with a magnifying system of electron optical lenses in which the charges carried by the electron rays in the region of the observed object to be investigated are used for scanning the focusing beam of rays. The distinguishing feature of the device is that the terminal image screen is electrically connected to a deflecting electrode which, viewed in the direction of motion of the rays, is positioned behind the objective. To compensate for the deflection of the beam of rays induced by the electrode another deflecting electrode is adapted whose potential is varied by means of the compensating circuit. (ATD)

10675 DETECTOR PROBE OF RADIOACTIVE RADIATION. Dokoupil, S.; Polivka, V. Czech Patent 927-64.

A radiation detector-probe was introduced which incorporates a photomultiplier whose anode or output dynode is connected to an integrating capacitor by a feed resistor. The resistor feeds a current amplifier whose input impedance is substantially lower than the feed resistance; therefore, the time constant of the response decay is predominantly determined by the integrating capacity and the feed resistance. Four points of the patent are enumerated. (ATD)

Radiation Dosimeters

Refer also to abstracts 11330 and 11936.

10676 (AD-640298) MATERIAL FOR MANUFACTURING IONIZING CHAMBERS WHICH MEASURE THE DOSE OF X-RAY RADIATION. Garapov, E. F.; Lebedeva, M. F.; Shchekin, K. I. Translation of Russian Patent 169776. 8p. (FTD-TT-65-1302). CFSTI $3.00 cy, $0.65 mn.

A material is proposed for making ionization chambers which measure the dose of x radiation. It consists of 45 to 50% of polyethylene and 50 to 55% of graphite. Such a composition makes it possible to prepare chambers which possess a run with rigidity of ±10%. (B.G.D.)

10677 (BNWL-332) NEUTRON DOSIMETRY USING THE FISSION FRAGMENT DAMAGE PRINCIPLE. Baumgartner, W. V.; Brackenbush, L. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1966. Contract AT(45-1)-1830. 15p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Data are given on the developments to incorporate the fission fragment damage principle into a personnel neutron dosimeter. Plastic, glass, and minerals used in conjunction with fissionable materials (^{235}U and ^{237}Np) provide the basis for a full energy spectrum neutron dosimeter. Prototype dosimeter results show marked improvement in dose response when compared to nuclear track emulsions neutron dosimeters. The fission fragment neutron dosimeters permitted dose evaluation in several neutron energy groups in mixed gamma and neutron radiation fields. Theoretical and experimental studies indicate that fast neutron doses as low as 150 mrem and thermal neutron doses of 1 mrem can be measured. (S.M.H.)

10678 (CLOR-51/D) DOBOR FILTROW W DAWKOMIERZU FOTOMETRYCZNYM DO POMIARU PROMIENIOWANIA X I GAMMA O ENERGII POWYZEJ 75 keV. (Film-Badges Filter Combinations for Measurement of X and Gamma Radiation Above 75 keV). Musialowicz, T.; Wysopolski, J. (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1966. 18p. (In Polish). Dep.

The results of investigations of filters for reducing the energy-dependence of the Foton-films in dosimetry of electromagnetic radiation of various energies. The film response was investigated using normally filtered x-ray spectra (normal radiation), 50-200 kV, and gamma emitters I-131, Cs-137, Ra-226 and Co-60. The best linearity in energy range 75 keV to 1.25 MeV was obtained by using the filter of 0.3 mm Pb + 0.6 mm Sn (tin adjacent to film). For this filter the relative response of Foton Roentgen-Super film to Ra-226 radiation at 0° incidence in mentioned energy range was between 1-1.1. (auth)

10679 (N-66-21014) DEVELOPMENT OF A FLIGHT-QUALIFIED WHOLE-BODY DOSIMETER SYSTEM. Final Report. Wiley, R.; Fletcher, C. L. (General Dynamics/Fort Worth, Tex.). Sept. 9, 1965. Contract NAS9-3407. 115p. (NASA-CR-65304; FZK-258). CFSTI $3.00 cy, $0.65 mn.

The development and construction of a whole-body dosimeter system for monitoring the radiation exposure to crew members during space missions is described. The system is a flight-qualified, self-contained unit consisting of a 6.8-cc ion chamber, electrometer, and electronics to drive a three-hand readout register. The system is capable of reading 0.1000 rad in 0.01-rad increments at a maximum rate of 108 rad/hr. The system weighs 0.8 lb, has a volume of 18.3 $in.^3$, and is contour shaped for compactness and easy handling. Construction details of the system,

reliability estimates, qualifying tests, and operating instructions are given. (auth)

10680 (NP-16507) PILOT COMPARISON OF TWO THERMOLUMINESCENT DOSIMETRY SYSTEMS WITH FILM BADGES IN ROUTINE PERSONNEL MONITORING. Johnson, T. L.; Attix, F. H. (Naval Research Lab., Washington, D. C.). Jan. 3, 1967. 34p.

An intercomparison was made of the performance of two thermoluminescent dosimetry (TLD) systems and conventional film badges in a routine γ-ray personnel monitoring operation. Quartz fiber pocket dosimeters were worn in some cases also, but were read out more frequently than the monthly interval used for the other systems. One of the TLD systems consisted of the U. S. Navy experimental prototype Computer-Indicator CP-748(XN-1)/PD and Detectors DT-284(XN-1)/PD, (respectively the "reader" and "dosimeters"). The other was a commercial model of foreign manufacture which will be referred to here as the "M" system. Both of these types of dosimeters employed calcium fluoride TLD material sealed in a glass envelope with an internal ohmic heater. The M dosimeters were found to agree with the DT-284's within 10% + 6 mR almost without exception, and within 10% + 3 mR in three cases out of four. The quartz-fiber dosimeters agreed with the DT-284's within 10% + 6 mR in three fourths of the cases. 20 mR was regarded as the minimum exposure detectable with the film; in the 31 cases where the film exceeded this minimum, it also exceeded the DT-284 reading by 10% + 25 mR in 18 cases, and by 10% + 50 mR in 8 cases. Both types of TLD's were found to contain radioactive contamination which gave rise to background readings in excess of ambient background by ≈21–24 mR/mo. (auth)

10681 (USNRDL-TR-1097) COLOR FILMS FOR MEGARAD DOSIMETRY. Menkes, C. K.; Goldstein, N. (Naval Radiological Defense Lab., San Francisco, Calif.). Oct. 13, 1966. 50p.

Dyed color films manufactured for theatrical lighting were tested for dosimetric response between 10^5 and 10^8 roentgens. Optical density for 61 colored films as a function of wavelength was measured before and after an exposure of 50 million roentgens. Based on the sensitivity and stability of the 61 exposed films, two were investigated for change in optical density at an optimum wavelength as a function of exposure value. The effect of storage temperature was also investigated for one of the films. (auth)

10682 AMMONIUM MOLYBDATE AS A DOSIMETER FOR γ-RADIATIONS. Oza, P. M.; Rao, P. S. (Central Salt and Marine Chemicals Research Inst., Bhavnagar, India). Bull. Chem. Soc. Jap., 40: 239(Jan. 1967).

A simple chemical dosimeter in the range of 10^4 to 10^7 R using ammonium molybdate solutions is described. In the range of 10^4 to 10^6 R reduction of ammonium molybdate was linear with dose in alcohol solutions. A similar linearity was observed with tetrahydrofuran in the range of 10^5 to 10^7 R. The radiation dose can be estimated by either taking the absorption spectra or titrating against potassium permanganate. (D.H.M.)

10683 MINIATURE INSTRUMENT FOR MEASUREMENT OF MEAN TOTAL RADON CONCENTRATION. Kirichenko, V. N.; Borisov, B. N.; Ogorodnikov, B. I.; Kachikin, V. I.; Basmanov, P. I. At. Energ. (USSR), 21: 217-18(Sept. 1966). (In Russian).

Current dosimetric control measures for the protection of miners exposed to radiation are based on a discontinuous sampling of the air; determination of the radon content is therefore not reliable. A small instrument that can be conveniently worn on the body of the worker, was developed. It consists of a cylindrical container which protects its nuclear emulsion from light. The radon must pass through a filter which retains the daughter products and the dust. The emulsion records the emitted α particles for four hours; the radon content of the atmosphere is calculated from the density of the developed film. The lowest measurable concentration after 36 hours in the work area amounts to 5×10^{-12} Ci/l. The standard deviation from the theoretical value in 50 measurements was found to be 26%. The device operated successfully and reliably under actual working conditions. (TTT)

10684 APPLICATION OF SGD-8 GLASSES FOR GAMMA DOSIMETRY OF IGR PULSE REACTOR. Sharoiko, S. A. At. Energ. (USSR), 21: 218-19(Sept. 1966). (In Russian).

The special SGD-type glass used for γ dosimetry in the IGR reactor was calibrated with the 2000-Ci γ source of the I. V. Kurchatov Institute, measuring the optical density of the glass a few days after the irradiation. The dose rate at the location of the glass specimen was determined by means of a ferrosulfate-type dosimeter. In view of the fact that a ^{60}Co source, rather than the reactor, was used for the calibration, compensating lead filters were placed in the system. It was also taken into consideration that the reactor operates in bursts of <0.5 sec while the cobalt source was operated for periods up to 4 hours during the calibration, by delaying the optical density measurements for several days. A check of the calibration by calorimetric measurements revealed that the precision of the dosimetric measurements by means of the glass amounts to 10%. It was concluded that the SGD-type glass is suitable for measuring the γ radiation of all sources, including that of reactors. (TTT)

10685 PHOTOSENSITIVITY OF CLEAR PERSPEX DOSIMETERS. Whittaker, B.; Lowe, C. A. (Atomic Energy Research Establishment, Wantage Research Lab., Eng.). Int. J. Appl. Radiat. Isotop., 18: 87-91(Jan. 1967).

The photosensitivity of irradiated clear Perspex is discussed. It is shown that large post-irradiation changes take place on exposure of Perspex dosimeters to visible or uv light. Test results suggest that it is the uv component of daylight which gives rise to fading. This is readily understood if it is assumed that a radical trapping process is responsible for irradiation coloration. Exposure to uv radiation would result in the release of loosely trapped radicals. It is concluded that in order to avoid errors due to photosensitivity the dosimeters should be enclosed in uv absorbing package materials, such as thin aluminum foils, or possibly polyvinylchlorides, or acetate sheets containing a uv absorbing dye. Metal foils should be sufficiently thin to avoid interfacial electron equilibrium effects. (UK)

10686 CELLOPHANE DOSIMETRY OF ELECTRON BEAM GENERATED BY VAN DE GRAAFF ACCELERATOR. Chen, Tsan-jen; Yeh, Si-jung. J. Chin. Chem. Soc. (Taiwan), 12: 127-37(Dec. 1965).

The electron-beam dose generated by Van de Graaff accelerators was measured using a ceric-cerous dosimeter. Two kinds of cellophane dosimeters (Type A and Type B) were used to provide a simple means for routine measurement of the dose. It was demonstrated that a linear relationship existed between optical density changes of the cellophane dosimeter and the total electron dose in the range of 2.0×10^5 to 8×10^6 (Type A) and 2.0×10^6 to 6×10^7 (Type B) rads, respectively. (auth)

Radiometric Instruments

Refer also to abstracts 10319, 10550, 10551, and 11244.

10687 (N-66-21002) STUDY OF HEAT-SENSITIVE RADIOISOTOPES FOR TEMPERATURE MEASUREMENT APPLICATION. Final Report. Hutchinson, H. D. (Meteorology Research, Inc., Altadena, Calif.). July 1965. Contract NAS9-3403. 49p. (NASA-CR-65264; MRI-65-FR-283). CFSTI $3.00 cy, $0.65 mn.

A research program to experimentally select a series of carrier materials which decompose at fixed temperatures in the range 300 to 1200°F is reported. These provide a means of continuously tracking the propagation front of an isothermal surface through a virgin nose cone material. The study of heat-sensitive radioisotopes for temperature measurement is an extension of the RMS-3A radioactive ablation sensor system which is based on a radioactive source emitting gamma rays, a Geiger-Muller detector tube, and solid state electronic circuits. Essentially, the same system is used to sense a temperature front rather than an ablation front by using a linear radioactive source. Relative to use with this system various investigations were made of heat sensitive carrier compounds. The compounds suitable for use are given along with their effective temperature range, and include anthraquinone; hexamethylene; ammonium tartrate, chloride, sulfate, and iodide; sodium chlorate; potassium metaperiodate and perchlorate; and sodium bisulfite. (STAR)

10688 MOISTURE GAUGE CALIBRATION BASED ON THE DISTRIBUTION OF NEUTRONS SCATTERING IN CONSTRUCTION MATERIALS. Apostol, E. (Inst. of Atomic Physics, Bucharest). Nucl. Eng. Design, 4: 322-8(Oct. 1966).

The counting rate, measured by a counter with BF_3, for slow neutrons scattering in material containing water, is presented under three terms. The counting rate given by the theory of neutron transport in water is used as the first term; the counting rate obtained on dry and homogeneous test material is used as the second, and the apparatus background counting rate as the third term. The average distance between source and counter is established by means of a nomogram in terms of moisture. The influence correction of the drill hole diameter is realized by multiplying the counting rate by a cavity factor obtained from the ratio between the counting rates for a certain cavity and those for the reference cavity. By utilizing the proposed method of measuring the above-mentioned three counting rates and the counting rate of a test material with known moisture, the radiometric moisture gage can be easily calibrated without using the classical calibration method, which is very difficult to apply for a great number of points in the entire moisture measuring range. The proposed

method is checked by comparing the calculated calibration curve with the experimental curve for two average distances between source and counter, and for different materials like: soil, sand, aggregates, and cement concretes. (auth)

10689 MEASUREMENT EQUIPMENT FOR TECHNICAL USE OF RADIONUCLIDES. Kosmowski, Alfred (Frieseke and Hoepfner GmbH, Erlangen-Bruck, Ger.). Z. Instrum., 74: 291-4(Sept. 1966). (In German).

The suitability of sealed radiation sources containing certain radionuclides such as ^{147}Pm, ^{85}Kr, ^{204}Tl, ^{90}Sr, ^{90}Y, ^{106}Ru, ^{106}Rh, ^{137}Cs, and ^{60}Co for measurement of thickness, and Ra–Be or Am–Be sources for measurement of mixture content are reviewed. Recent uses of currently developed transistorized equipment, equipment configuration for single or double sided measurements, principles of thickness measurement with radioisotopes, examples of equipment, and measurements of suspensions are discussed. Humidity and moisture content measurements with neutron sources are illustrated by examples found in bulk goods manufacturing and in soil moisture studies. Examples of equipment used and their sensitivity characteristics are discussed briefly. Measurements of moisture content may require from 15 to 180 sec and give results with an accuracy range between 0.1 to 0.3% moisture. Soil moisture content can be measured with an accuracy of ~1%. (BBB)

Miscellaneous Instruments and Components

Refer also to abstracts 10525, 10527, 11297, 11548, 11912, and 12255.

10690 (CEA-R-3073) CALORIMETRE MIXTE A HELIUM-3 ET HELIUM-4. CALORIMETRIE A TRES BASSE TEMPERATURE. (Mixed ^3He–^4He Calorimeter. Very Low Temperature Calorimetry). Testard, Olivier (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1966. 113p. (In French). Dep. mn.

Thesis. Submitted to Univ., Paris.

A description is given of a double-jacket calorimeter using helium-4 and helium-3 as the cryogenic fluids and making it possible to vary the temperature continuously from 0.35 to 4.2°K. By using an electric thermal regulator together with liquid hydrogen it is possible to extend this range up to about 30°K. A review is made of the various methods available for measuring specific heats. The method actually used in the apparatus previously described is described in detail. The difficulties arising from the use of an exchange gas for the thermal contact were solved by the use of adsorption pumps. (auth)

10691 (COO-1328-15) COMPACT MOLECULAR BEAM VELOCITY SELECTOR. Grosser, A. E.; Bernstein, R. B. (Wisconsin Univ., Madison. Theoretical Chemistry Inst.). Sept. 1, 1965. Contract AT(11-1)-1328. 8p. (WIS-TCI-117GX). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A recently constructed short-path, high-transmittance slotted-disk velocity selector of modest resolution is described. Its main characteristics are: total path length 2.1 cm, resolution (FWHM) 26%, and transmission factor (open time) 45%. (B.G.D.)

10692 (IFA-IS-38) MULTIMODULATED CYCLOTRON MASS SPECTROMETER WITH ALTERNATING PULSES. Ioanoviciu, D.; Mercea, V. (Academia R. P. R., Bucharest. Institutul de Fizica Atomica). 1966. 19p. Dep. mn.

The analytical calculus of the resolving power of a multimodulated cyclotron mass spectrometer (synchronometer) with alternating pulses is investigated. (B.G.D.)

10693 (INR-735/VI/E) UNIVERSAL'NYI PRIBOR ISPOL'ZUEMYI V YADERNOI FIZIKE DLYA REGISTRATSII IZMERITEL'NYKH DANNYKH. (An Universal Device for Recording of Experimental Results in Nuclear Physics Measurements). Stefan'ski, V.; Pakhala, S. (Institute of Nuclear Research, Warsaw (Poland)). July 1966. 34p. (In Russian). Dep.

The construction of a universal apparatus for registering the data from multichannel systems applied in nuclear physics is described. The work parameters obtained by means of this apparatus are also discussed. This system was applied in particular to registering the experimental data from a 34-channel time analyzer and a 450-channel hodoscope. (auth)

10694 (N-66-19668) RIVELATORI DI CORRENTE PER IL LINAC CON TRANSFORMATORI DI IMPULSO. Nota No. 293. (Current Detectors for the LINAC Using Impulse Transformers. Note No. 293). Renzler, G. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali de Frascati). Oct. 26, 1965. 29p. (In Italian). (LNF-65/37). CFSTI $3.00 cy, $0.65 mn.

The detection circuit and toroidal magnet are described for the detection of electrons and positrons from a linear accelerator. Also, the equivalent circuit is shown and the physical characteristics and dimensions of the transformer and detection circuit are given. (STAR)

10695 (N-66-37998) ELECTRIC FIELD METER FOR ROCKET AND SATELLITE USE. Potter, Wentworth Edwards (New Hampshire Univ., Durham. Dept. of Physics). Sept. 1966. 107p. (NASA-CR-78444; UNH-66-4). CFSTI $3.00 cy, $0.65 mn.

Thesis.

The evidence for the existence of electric fields in the ionosphere and magnetosphere is discussed. The auroral and electrojet current systems are studied in relation to the electric and magnetic fields. It is proposed to make, in situ, measurements of these electric fields estimated to be 0.1 to 100 mv/m using a high impedance differential electrometer amplifier. The ionospheric and magnetospheric media are described. Effects such as photoemission current, sheath distortion and the induced electric field due to probe motion are studied. A high impedance field effect electrometer amplifier has been designed, and a description of this as well as of a rocket experiment for measuring ionospheric electric fields is presented. A unique, unfurlable probe system will be used. (auth)

10696 (NASA-CR-704) THEORY OF ELECTROSTATIC PLANAR AND SPHERICAL PROBES. Parker, Lee W. (Mount Auburn Research Associates, Inc., Cambridge, Mass.). Jan. 1967. 94p. CFSTI $3.00 cy, $0.65 mn.

In the theory of an electrostatic plasma probe, the current is calculated by considering all possible trajectories corresponding to particles which impinge on the probe surface. The trajectories may or may not be populated, depending on the geometry of the probe and the structure of the potential distribution in its vicinity, as well as on the particle velocity distribution at infinity. By considering which trajectories are populated and which are not, a theoretical expression is obtained for the current collected by a planar probe assumed to be embedded in the skin of a large satellite in the ionosphere plasma. This expression is in the form of an integral over velocity space. The analytical properties of the domain in velocity space which corresponds to populated trajectories are investigated. The shape of the domain governs the current characteristics of the probe. General formulae are derived which depend on the shape of the domain. An approximate theory is employed to obtain an analytical form for the shape of the domain, and expressions are derived for the current characteristics of the probe. Comparison is made between the theoretically derived characteristics and those computed by numerical trajectory calculations. An approximate theory is also employed for the spherical probe, based on a power law potential model. The planar and spherical probes are compared. The circumstances under which Druyvesteyn relations exist are investigated for the planar and spherical probes. Under the assumption of a spherically symmetric potential, formulae are derived for the current collected by a spherical probe moving through a plasma. The theoretical current collection based on the power-law potential model is compared with the current based on the sheath model. (auth)

10697 (NP-16429) AMPLIFICATEURS CONTINUS A TRES GRANDE RESISTANCE D'ENTREE. UTILISES DANS LES AMPLIFICATEURS OPERATIONNELS DE MESURE. (Continuous Amplifiers with Very High Input Resistance. Uses in Measurements by Operational Amplifiers). Bernaudin, Ph. (Paris Univ., Orsay (France). Laboratoire d l'Accelerateur Lineaire). June 1966. 142p. (In French). Dep. mn.

The operational principle and the equivalence scheme of beam current measurements were reported. The theory of measurements in integrated value and in instantaneous value and the conditions required for the continuous amplifier were derived. Some operational amplifiers of the classic type, that is, a group of instantaneous current meters whose continuous amplifiers use electrometer tubes and current integrators whose continuous amplifier contains a mechanical vibrating condenser, were described. The complete study of a continuous amplifier with high input resistance using the variable junction capacity of two diodes was presented. A study was made on the MOS field effect transistors and their applications in the area of continuous amplifiers. (tr-auth)

10698 LOGARITHMIC CONVERSION OF PULSE AMPLITUDES INTO NUMBERS IN A WIDE DYNAMIC REGION. Gadalov, A. N.; Mineev, Yu. V.; Rapoport, I. D. Vestn. Moskov. Univ., Ser. III: Fiz. Astron., No. 4, 65-8(July-Aug. 1966). (In Russian).

A transistorized logarithmic converter for the conversion of the amplitudes of wave signals into the number of pulses was described. For the conversion an oscillating circuit was used.

The circuit presented makes possible the conversion of wave amplitudes in the wide region of 2×10^3 (from 3 mv to 6 b). (tr-auth)

10699 NUCLEAR ELECTRONICS: A UNIVERSAL LINEAR AMPLIFIER IN ESONE-TECHNIQUE. Friese, T. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Kerntechnik, 8: 473-6(Oct. 1966). (In German).

A universal linear amplifier in ESONE technique is described. The maximum gain is 512, it is adjustable in steps and continuously to less than unity. Input and output are switch-selected for both polarities. The output delivers ±10 V into 1 kΩ or ±5 V into 50 Ω, the rise-time being 0.16 μsec. A second output is delayed by 1.65 μsec. The amplifier built in a 1/8 ESONE plug-in (54 mm) is provided with single or double delay-line clipping (0.78 μsec), the amplifier built in a 3/8 ESONE plug-in has additional RC-differentiation and integration. (auth)

10700 RECORDING TECHNIQUES AND THE EXPLOITATION OF LANGMUIR SOUND CHARACTERISTICS. Haug, R. (CNRS, Nancy). Onde Elec., 46: 1251-9(Nov. 1966). (In French).

Following an account of the difficulties which arise in the measurement of collected current in a Langmuir probe situated in an ionized medium, a description is given of a measuring system using an operational amplifier. This technique is also used to examine the probe potential by the addition of different components. There is then an account of various different automatic systems of analogue derivation or the generation of harmonics chosen according to the speed required for making measurements on the ionized medium. Finally, there is an examination of an application example in the instance of a slow speed analysis. The accuracy obtained in the measurement of plasma potential is of the order of 10 mV. (auth)

10701 RESONANT-CAVITY TECHNIQUE FOR THE MEASUREMENT OF LEAKY-WAVE COMPLEX PROPAGATION COEFFICIENTS. Hessel, A.; Torrero, E. (Brooklyn Polytechnic Inst., Farmingdale, N. Y.). Electron. Lett., 3: 29-31(Jan. 1967).

A resonant-cavity technique for the measurement of k/β diagrams (dispersion relations) of leaky-wave structures is discussed. Theoretical calculations and measured results are presented for a specific structure of the class of leaky-wave structures considered. The extension of this technique to more general smooth and periodic structures is indicated. (auth)

10702 EQUIVALENT-CIRCUIT PARAMETERS OF A CYLINDRICAL-CAVITY RESONATOR. Toman, M. P.; Ishii, T. Koryu (Marquette Univ., Milwaukee). Electron. Lett., 3: 36-8(Jan. 1967).

A new approach is used to determine the parallel-equivalent-circuit parameters and the Q factor of a cylindrical-cavity resonator in the TM_{010} mode. By this approach, agreement is reached between equivalent-circuit considerations and field-energy methods. (auth)

10703 TRANSISTORIZED TIME-TO-AMPLITUDE CONVERTER. Dardini, C. (Laboratori Nazionali del Sincrotrone, Frascati, Italy); Iaci, G.; Lo Savio, M.; Visentin, R. Nucl. Instrum. Methods, 47: 233-43(1967).

A fully transistorized time-to-amplitude converter, based on the start-stop principle, is described. The converter exhibits a 10 ps intrinsic resolution and a 0.5 ns physical resolution (fwhm) using as detectors photomultipliers 56 AVP. The whole apparatus does not need selected components and presents good stability against the varying external temperatures. The measuring range is easily changeable by simply substituting a timing capacitor. (auth)

10704 COUNTER DECADES WITH BISTABLE AND THREE-STABLE CIRCUITS. Miskolczi, Janos. ATOMKI (At. Kut. Intez.) Kozlem., 8: 248-55(Sept. 1966). (In Hungarian).

The description of bistable and three-stable transistor circuits and counter decades constructed with the aid of these circuits is given. (auth)

10705 NUCLEAR ELECTRONICS: SCALER OR BUFFER STORAGE FOR HIGHER RESOLUTION IN PULSE COUNTING EQUIPMENTS IN RADIATION MEASUREMENT. Moll, G. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Kerntechnik, 8: 404-6(Aug.-Sept. 1966). (In German).

Counting loss in pulse counting equipment with dead time can be decreased by scalers or buffer storages. Both methods are compared. A simple buffer storage is described. (auth)

10706 PRINCIPLE AND APPLICATIONS OF THE ELECTRON BEAM MICROPROBE. Pawlitschek, Walter; Wright, Patrick W. (Fa. AEI-Sunvic-Regler GmbH, Solingen-Wald, Ger.). Z. Instrumentenk., 74: 248-54(1966). (In German).

In addition to an outline of microprobe analysis and the development of the technique, current instrumentation is described and recent advances in applications are reviewed. Older references to applications are given, but a particular importance is attached to a discussion of analysis of elements with low atomic number. Problems involved in the analysis of elements from B to Na include crystal size, windows for the proportional counter, and contamination of the probe by hydrocarbon deposits. The window is made of a 2000 Å-thick nitrocellulose film, and the hydrocarbons were avoided by introduction of external gas through a capillary near the point of deposition. The application of the technique to C analysis is illustrated, but results must be interpreted with caution, since the L and M lines of heavier elements often fall close to the K lines of lighter elements. (BBB)

10707 RESOLVING TIME OF A PULSED-NEUTRON SOURCE DATA-ACQUISITION SYSTEM. Bierman, S. R.; Garlid, K. L.; Clark, J. R. (Battelle-Northwest, Richland, Wash.). Nucl. Appl., 2: 515-18(Dec. 1966). (BNWL-SA-651).

In making pulsed-neutron source measurements, counting rates of such magnitude are often encountered that the characteristics of the data-acquisition system must be properly identified before corrections for coincidence losses can be accurately made. To account properly for coincidence losses at very high counting rates, it is necessary to determine how closely a perfectly paralyzable or completely nonparalyzable system represents the real detection system used in the measurements. A maximum observed counting-rate technique is presented which, in conjunction with a double-pulse method, permits the system to be characterized relative to these two theoretically limiting models. (auth)

10708 SIMPLE OSCILLOGRAPHIC METHOD FOR BALANCING ZERO-PASSAGE TRIGGERS. Langkau, R. (Institut fuer Experimentalphysik, Hamburg). Nucl. Instrum. Methods, 45: 351-2(1966). (In German).

A simple oscillographic method for the balancing of zero-passage triggers used in nuclear physics time measurements is described. The circuit for the oscillographic measurement is given. The oscillograph serves both as generator for the production of the test pulse and as time-pulse height converter for the quantitative measurement of the trigger time point. (J.S.R.)

10709 DEAD-TIME ERRORS IN DIFFERENCE COUNTERS. Lokajicek, M. (Forschungsbetrieb Tesla, Premysleni, Czechoslovakia). Nucl. Instrum. Methods, 46: 359-60(1967). (In Dutch).

An expression for the relative errors caused by dead time in difference counters was derived and represented graphically. (J.S.R.)

10710 MODIFICATION OF THE LABEN A51 ANALYZER FOR BIDIMENSIONAL HIGH RESOLUTION ANALYSIS. Castrica, F. (CNEN-CSN, Casaccia, Italy). Nucl. Instrum. Methods, 48: 157-61(Feb. 11, 1967).

The modification of a Laben A51 Analyzer is described, with the purpose to allow high resolution multiparameter analysis (auth)

10711 IMPROVEMENTS IN NEUTRON POLARIMETER. Miller, T. G. (Army Missile Command, Redstone Arsenal, Ala.). Nucl. Instrum. Methods, 48: 154-6(Feb. 11, 1967).

A neutron polarimeter which was described previously (Nucl. Instr. and Meth. 40, 93 (1966)) was improved to give better resolution and higher effective average currents. (B.G.D.)

10712 LOCALIZATION OF THE POSITION OF LIGHT IMPACT ON THE PHOTOCATHODE OF A PHOTOMULTIPLIER. Charpak, G. (CERN, Geneva). Nucl. Instrum. Methods, 48: 151-3(Feb. 11, 1967).

The possibility of creating very localized magnetic fields in such a way that only the photoelectrons coming from a limited area of a photocathode of a photomultiplier are perturbed is investigated. (B.G.D.)

10713 IMPROVEMENTS IN MEASURING APPARATUS. (to Compagnie Francaise Thomson-Houston). British Patent 1,050,306. Dec. 7, 1966. Priority date Apr. 29, 1964 and June 16, 1964, France.

The electronic system described is used in testing safety trip devices of a neutron flux monitoring channel without isolating the trip devices from the channel. A dc current amplifier supplies a correct testing signal for each trip device to be tested. The input of the dc current amplifier is connected to the output voltage of a measuring amplifier or an amplifier shunting device corresponding to the series of trip devices to be tested. The output of the dc current amplifier is fed to the inputs of the trip devices through a resistive element identical to the resistive elements through which the threshold and output voltage of the

measuring amplifier, or shunting device are applied to the trip devices. (F.S.)

10714 X-RAY PROGRAM CONTROLLER, MODEL 35-199 (Engineering Materials). (du Pont de Nemours (E. I.) and Co., Aiken, S. C., Savannah River Lab.). (CAPE-1528).

14 drawings

A time-based program controller using a prepunched tape for automatic goniometer scanning of an x-ray diffractometer in which the locations of the diffraction lines are known is described. The program controller consists of a dual-speed drive unit which moves the goniometer rapidly over portions of the diffraction pattern not under observation and slowly over the diffraction lines to be observed, and an electronic control system which will scan the selected diffraction lines, print the accumulated data for each line, reset the goniometer, rewind the control tape, and then either stop or repeat the cycle. The control accuracy is within 0.01° Bragg 2θ angle. (For details, see TID-4100 Suppl. 38.) (F.S.)

10715 NIM SYSTEM REGULATED POWER SUPPLY [2832] (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1463).

15 drawings

The power supply was designed to be rear-mounted on a NIM Standard Bin (see CAPE-1477). The supply provides ±12 V and ±24 V at a maximum current of 1 A. Each voltage is independently current limited at ~1.2 A. The power supply provides remote sensing at a laminated Cu power distribution bus located on the bin. A thermostat located in the supply will close when the ambient temperature is 55°C ± 3°C and will open at 46°C ± 4°C. On the ORNL bin this will turn on an ambient lamp located on the front of the bin. Another thermostat located on the power supply heat sink will open at 95°C ± 3°C and close at 75°C ± 8°C. On the ORNL bin this will turn on an overload lamp located on the front of the bin and will turn off the power supply until the heat sink has cooled. (For details see TID-4100 Suppl. 38.) (F.S.)

Radiation Effects on Instruments and Instrument Components

Refer also to abstracts 10969 and 11706.

10716 (N-66-38342) AMBIPOLAR DIFFUSION OF A PLASMA CLOUD IN A TFY. Bryant, Floyd R.; Fales, Carl L. (Max-Planck-Institut fuer Physik und Astrophysik, Munich (West Germany)). Oct. 1966. 45p. (NASA-TN-D-3630). CFSTI $3.00 cy, $0.65 mn.

Silicon n- and p-channel planar diffused junction, silicon n-channel epitaxially grown junction, and germanium n-channel alloy junction field effect transistors were irradiated with 22- and 128-MeV protons. Transistor curve tracer photographs of the drain characteristic curves were obtained at various integrated proton flux levels and several electrical parameters were determined. Simple theory from a model based on initial carrier removal rate indicates a linear and quadratic dependence of zero gate transconductance and drain current on integrated proton flux, respectively. Two of three transistors studied possessed zero gate transconductance variations in reasonable accord with the anticipated first degree dependence. In contrast, the curves of zero gate drain current as a function of flux of the third type adapt well to a straight line fit. The quadratic dependence of the zero gate voltage drain current fails, but a power law relation with proton flux holds and the exponents range from 1 to 1.6. Accurate radiation damage prediction for the transistors is not easily obtained because of the initial spread in their irradiation responses. (auth)

10717 ENVIRONMENTAL TESTING OF SNAP 10A INSTRUMENTATION. Johnson, J. L. (Atomics International, Canoga Park, Calif.). Contract AT(11-1)-GEN-8. pp 33-9 of Institute of Environmental Sciences 1966 Annual Technical Meeting, Proceedings. Mt. Prospect, Ill., Institute of Environmental Sciences, 1966.

The performance of the SNAP 10A instrumentation during component qualification ground system and flight system tests is reviewed. Environmental conditions imposed during component and system qualification tests are reviewed and test results are discussed. (auth)

10718 LARGE AREA UNIFORM ELECTRON BEAMS FOR SPACE RADIATION ENVIRONMENT STUDIES. Favale, Anthony J. (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). pp 65-72 of Institute of Environmental Sciences 1966 Annual Technical Meeting, Proceedings. Mt. Prospect, Ill., Institute of Environmental Sciences, 1966.

A technique was developed that provides unscanned large area uniform electron beams for space radiation environmental studies. With this technique, beam uniformities of better than 4 parts per 100 were demonstrated with an electron beam whose beam divergence half angle is 7.5°. The technique, developed at Grumman's Nuclear Radiation facility, was used at this facility to study the effects of Starfish radiation on the NASA/Goddard Orbiting Astronomical Observatory (OAO) star trackers, on the two atmospheric airglow experiments aboard NASA/Goddard Orbiting Geophysical Observatory (OGO), and on isolated RCA 1P21 photomultiplier tubes. The results of these tests, which agreed with the data that have been received from the presently orbiting OGO, show that the simulated radiation environment induces noise in the photomultiplier tubes present in all of these subsystems. (auth)

10719 ELECTROCHEMICAL CELL WITH DIRECT CONVERSION OF IONIZING RADIATION INTO ELECTRIC ENERGY. Zagorski, Zbigniew Pawel (Inst. of Nuclear Research, Warsaw); Panta, Przemyslaw Piotr. Nukleonika, 11: 681-3(1966).

A cell was developed in which ionizing radiation develops a potential difference and thus generates electric energy. The cell comprises a sandwich or coil of 50-μ Al foil electrolytes separated by 100-μ layers of semiliquid electrolyte (ammonium glycol borate in ethylene glycol). The behavior of the cell upon irradiation depends on the resistance of the external circuit; if it is low, a current is produced which stops upon interruption of the irradiation. Analogies and possible dosimetric applications are discussed. (D.L.C.)

10720 SPACE CHARGES IN IRRADIATED INSULATORS. Asch, Georges; Felix, Marie-Claude; Ongaro, Roger (Faculte des Sciences, Lyon). Ind. At., 10: No. 11, 66-70(1966). (In French).

The study of gamma and x ray effects on space charge in insulators includes the effects of polarization of the dielectric, the charge liberated by breakdown, the breakdown field, the simultaneous action of radiation on an electric field, and the action of a field after irradiation. (J.F.P.)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 10250, 10856, 10866, 10873, 10904, 10920, 10963, 11001, 11002, 11042, 11073, 11116, 11123, 11134, 11139, 11160, and 12098.

10721 (CEA-R-3054) CONTAMINATION EXPERIMENTALE DE MARGARITANA MARGARITIFERA (L) (BIVALVE D'EAU DOUCE) PAR LE CESIUM 137. (Experimental Contamination of Margaritana Margaritifera (L) (A Fresh Water Bivalve) by ^{137}Cs). Foulquier, Luc; Bovard, Pierre; Grauby, Andre (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). 1966. 46p. (In French). Dep. mn.

Cesium-137 was assayed in Margaritana margaritifera L. downstream from the Monts d'Arree nuclear power station. Methods for sample preservation and fixation of the ^{137}Cs concentration factors are described. In experiments carried out over a period of 100 days, the specific activity of the various organs was shown to stabilize after 30 to 35 days. A relatively low adsorption was noted on the shell in contrast to a rapid and high absorption by the soft tissues. Adsorption onto the shell was affected by intermediary microorganisms. Concentration factors at equilibrium were approximately: 9 for the shell, 300 for soft tissues, and 38 for the entire animal. Results are compared with work published previously by others, and the mechanism of ^{137}Cs fixation by lamellibranchs is discussed. (H.G.D.)

10722 (COO-414-4) DETAILED CHARACTERIZATION OF SOIL AND VEGETATION ON SELECTED SITES TO SERVE AS BASIS FOR FUTURE EVALUATION OF EFFECT OF RADIOACTIVE CONTAMINATION. Technical Progress Report, March 1, 1966–November 21, 1966. Haghiri, F. (Ohio Agricultural Research and Development Center, Wooster). Nov. 17, 1966. Contract AT(11-1)-414. 73p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A preliminary investigation on the vertical movement of radionuclides in cracking and non-cracking soils was conducted. Soil core samples from four different sites at two depths (0 to 10 in. and 10 to 14 in.) were obtained for ^{90}Sr and γ emitting radioisotope assays. Soil, plant materials, runoff water, runoff sediment, and leachate samples from field plots were assayed for ^{90}Sr and stable Ca. The percent ^{90}Sr in the 4 to 8 in. depth soil cores from the ^{90}Sr treated plots varied considerably. The percent activity ranged from 2.56 for rotation b to 8.11 for soil mulched with gravel. The movement of ^{90}Sr in the soil profile was higher under more acidic than under less acidic conditions. Total ^{90}Sr removed from plots treated with ^{90}Sr was 4.0212, 3.2093, 2.1410, 1.9005, and 0.9321% for gravel mulch, alfalfa rotation b, alfalfa rotation a, continuous corn, and permanent grass respectively. Before the soil samples were methylated, they were hydrogen saturated. The adsorption of Sr by the H-saturated samples was less (up to 40%) than the NH_4^+ saturated samples. Methylation and subsequent saponification did not appreciably alter the adsorption of Sr by the mineral soils. However, methylation did decrease the quantities of Sr adsorbed by the organic soils. The carboxyl groups are found to be the reactive functional groups for Sr in the organic soils. In the muck soil, the phenolic groups also contributed to the adsorption of Sr. Plant residues containing ^{90}Sr were incubated with four different soils. The soil columns were watered frequently and leachate collected. No ^{90}Sr was detected in the leachate from any of the soils. After 14 months, the columns were sectioned and each section analyzed for ^{90}Sr. The runoff water collected from the continuous corn plot was concentrated. The concentrate was electrodialyzed. Fifty percent of the ^{90}Sr migrated to the anode compartment. Twenty-five percent of the ^{90}Sr was in each of the other compartments. Therefore, $^1/_2$ of the ^{90}Sr is associated with negatively charged particles. The uptake of ^{90}Sr and ^{65}Zn by plants was correlated to the stability constants of the metal-soil complexes. The uptake of the cation decreased rapidly with an increase in stability constant. The decrease is linear for Hoytville and muck soils. However, the decrease for the CHT-41 soil is probably nonlinear. The distribution of γ-emitting isotopes in soil as influenced by forest canopy trees was studied. The effect of this distribution on the uptake of radioisotopes by plants was measured. The concentration of fission products in the soil near the stem of some trees was five times higher than in soil at other positions under the canopy. The magnitude of this concentration was apparently related to the quantity of stemflow water, which may be appreciable with some trees and negligible with others. Leaching of some radioisotopes in soil adjacent to tree stems, as a result of stemflow, was even higher than that shown earlier. Soil close to the stem of most trees had higher ^{137}Cs, organic carbon, and exchangeable K, lower pH than did soil farther from the stem. Herbaceous plants and spicebush growing close to the stems of canopy beech trees had higher uptake of fission products than those growing at other positions under the canopy. Bark samples from a hickory and a white oak tree had higher fission product contents than did bark from a beech tree. (auth)

10723 (N-66-21274) DE INVLOED VAN RONTGENSTRALING OP DE DELINGSCYCLUS VAN IN VITRO GEKWEEKTE CELLEN. (The Effect of X-Irradiation on the Division Cycle of Cells in Tissue Culture). Bootsma, D. (Rijksverdedigingsorgansatie TNO, Rijswijk (Netherlands). Medisch Biologisch Laboratorium). Apr. 1965. 82p. (In Dutch). (MBL-1965/9; TDCK-144603). CFSTI $3.00 cy, $0.65 mn.

The first post irradiation generation cycle of human cells in a monolayer asynchronous tissue culture was studied. By labeling cells with ^3H-thymidine it was demonstrated that the generation cycle could be divided into four phases based upon the synthesis of DNA. If a pulse labeling with ^{14}C-thymidine were followed by labeling with ^3H-thymidine until fixation, mitoses of cells before, during, and after DNA synthesis could be identified. The influence of irradiation on the entrance of cells into mitosis was studied in synchronous cultures by irradiation at different intervals of time after a second treatment with 7.5 mM thymidine. It was found that mitotic delay is caused by an inhibition of progression in the phase following DNA synthesis. Cells irradiated during this phase were blocked for long periods of time. Cells which were irradiated before and during DNA synthesis were blocked for lesser periods of time. These differences in degree of mitotic delay were found to bring about partial synchronization leading to increase of the mitotic index. (auth)

10724 (NP-16209) STUDIES ON PRIMARY RADIATION DAMAGE AND MECHANISM OF RADIOSENSITIVITY. Progress Report No. 5, April 1–December 31, 1965. (Atomic Energy Establishment, Trombay (India). Biology Div.). IAEA Contract 187/RB. 15p. Dep. mn.

Studies are reported on: the effects of glycerol on free radical reactions in irradiated trypsin, and reactions of OH radicals with nucleic acid bases and some amino acids and proteins; and the dose response in adenine, thymine, and uracil and also in the equimolecular complexes of adenine-thymine and adenine-uracil. Tryspin was freeze-dried from aqueous solution that contained 15% glycerol by weight of the protein present. After irradiation and observation at 77°K, the ESR spectrum showed an asymmetrical line and no radicals due to glycerol were obtained. At room temperature CH_2S radicals and the doublet signal were found to grow as usual. The new radical species was invariably present in all samples (DNA, bovine serum albumin, and gelatin) that contained glycerol. It is postulated that the new radical is formed by loss of alpha-hydrogen from glycerol. Reactions produced by OH radicals generated by the oxidation of titanous ions with hydrogen peroxide were studied by ESR spectroscopy using a flow system. In another series of experiments attempts were made to study the reactions at slightly higher pH values. Complexing with EDTA and working at pH 2 did not affect the ESR spectra from uracil or cytosine. The main reactions of OH radicals with purines appeared to be hydroxylations at the 8 position of the ring and the breakdown of the imidazole ring. Experiments on dose response and decay characteristics of thymine and uracil at 77°K confirmed that migration of radiation damage from the pyrimidine ring to the methyl protons takes place even at the temperature tested. It is therefore concluded that the intramolecular energy migration observed may be either due to electron or charge transfer or to exciton interaction. Experiments carried out so far have further indicated that the free radical yield of the adenine-thymine complex is less than the sum of the yields of the two constituents on an equimolecular basis while that of the adenine-uracil complex is more beyond a certain dose. (H.G.D.)

10725 (ORNL-P-2644) A TWO-COMPARTMENT MODEL WITH A RANDOM CONNECTION. Bernard, S. R.; Uppuluri, V. R. Rao (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 23p. (CONF-661010-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Symposium on Compartments, Pools, and Spaces in Medical Physiology, Oak Ridge, Tenn.

The nonuniform distribution of bone-seeking radionuclides and the effect of age on retention of strontium by dogs are considered in view of a mathematical study of a compartmental system in which the connections between the compartments are random

variables. Both single-compartment models with random flow and two-compartment models with random flows were studied. Generalizations of the models are discussed. (H.G.D.)

10726 (ORO-3489-2) THE EFFECTS OF RADIATION AND IMMUNOSUPPRESSIVE DRUGS ON ANTIBODY FORMATION AND ALLERGY. Progress Report, December 1, 1965–August 10, 1966. Jennings, B. R. (Tennessee Univ., Memphis). Oct. 6, 1966. Contract AT(40-1)-3489. 9p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Experiments were designed to explore the temporal relation between the combined administration of actinomycin D and x rays and the antigenic stimulus in female mice given a primary antigenic stimulus of aluminum phosphate adsorbed tetanus toxoid at least 21 days before the secondary antigenic stimulus of fluid tetanus toxoid. By using low doses of actinomycin D and x radiation, the potentiating effect was evident. Data indicated that potentiation is demonstrated only when the agents are given prior to antigenic stimulus. Each agent appeared to act independently when administered after the antigen stimulus. (H.G.D.)

10727 (SU-326P7-17) REPAIR OF DAMAGED DNA IN VIVO. Progress Report. Hanawalt, Philip C. (Stanford Univ., Calif. Biophysics Lab.). Nov. 1966. Contract AT(04-3)-326. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Studies on the in vivo repair of uv-damaged DNA are reported in respect to the relation of repair to: mutagenesis, survival, genetic recombination and prophage induction, inhibition by various reagents, and normal replication. Pulse labeling was used to investigate the reorientation of chromosome replication in E. coli. (H.G.D.)

10728 (TID-23458) THE EFFECT OF CHAIN LENGTH UPON THE BIOLOGICAL UPTAKE AND DECAY OF ^{32}P-LABELED INORGANIC POLYPHOSPHATES IN RATS. Katchman, Bernard J.; Bartram, Stephen L.; Blanchard, W. Warren; Beemsterboer, George L. (Miami Valley Hospital, Dayton, Ohio. Dept. of Research). [1961]. Contract AT(11-1-)-1253. 45p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Sodium polyphosphates ($\bar{n}$ 40 to $\bar{n}$ 170) ($\bar{n}$ = chain length) and potassium polyphosphates ($\bar{n}$ 127 to $\bar{n}$ 784) labeled with ^{32}P were synthesized and injected into rats. When compared with ^{32}P-orthophosphate, the 24-hour concentrations of radioactivity from the polyphosphates in soft tissues were significantly lower; only the polyphosphates with $\bar{n} < 170$ showed higher radioactivity than orthophosphate in liver, lung, and spleen. The 24-hour concentrations of radioactivity in tissues due to polyphosphates or orthophosphate are less than 1% of the injected dose; brain and muscle concentrations are always lowest. The polyphosphates with $\bar{n} <$ 170 show concentrations slightly greater than 1%. Relative to blood, the 24-hour concentrations are higher in all tissues (except brain) injected with polyphosphate or orthophosphate. Thus, the tissues are able to maintain concentration gradients. The biological half-life of radioactivity 24 hours post-injection is the same for all tissues and all injected materials. In bone, the 24-hour concentrations are found to vary with the chain length of the polyphosphate. The longer the chain the greater the uptake; the logarithm of chain lengths is linear with uptake. The polyphosphate uptakes, however, approach that of orthophosphate only at the longest chains tested. The biological half-life of the polyphosphates greater than $\bar{n}$ 40 are two to three times longer than orthophosphate. (auth)

10729 (TID-23484) ^{137}Cs IN PEOPLE AND FOOD IN NORWAY, 1963–1966. Madshus, Kjell (Norsk Hydro's Inst. for Cancer Research, Oslo); Stroemme, Aksel (Norsk Radiumhospital, Oslo); Koren, Kristian (Statens Radiologisk-Fysiske Laboratorium, Oslo (Norway)). Contract AT(30-1)-3364. 6p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Data on ^{137}Cs levels in Norway collected during the period 1963 to 1966 are reported. Special attention was devoted to measurements of people and food from districts in Western Norway where the average annual rainfall is 3500 mm/yr. Measurements of milk samples taken from the whole of Norway as well as measurements of selected groups of Norwegians were carried out regularly during the same period. Systematic investigations of foodstuffs were performed in 1964 and 1965. (H.G.D)

10730 (UCRL-Trans-10035) THE FIXATION OF AcK, ^{134}Cs, AND ^{86}Rb IN EXPERIMENTAL SARCOMATA AND GRANULOMATA IN THE RAT. Perey, M.; Chevalier, A.; Lausecker, C. Translated for Univ. of California, Lawrence Radiation Lab., Livermore, from Comp. Rend. Soc. Biol., 146: 1141-3(July 1952). 11p. Dep. mn. JCL $1.60 fs, $0.80 mf.

In previous studies it was shown that actinium K (francium-223) injected into rats with experimental sarcomata was fixed more strongly in the sarcomata than in the surrounding muscular tissue. Rubidium-86 and cesium-134 were injected subcutaneously into rats with experimental sarcomata produced by 3,4-benzpyrene. After the animals were killed, activity was measured in tumor and muscle tissue. Results are tabulated. Cesium-134 was fixed more strongly in the sarcomata than in the muscle tissue, while rubidium-86 was not more strongly fixed in the sarcomata. In other experiments using rats with experimental granulomata, actinium K and cesium-134 were injected. After the animals were killed, it was found that these isotopes were more strongly fixed in the granulomata than in the muscle tissue. (H.L.W.)

10731 EFFECT OF X IRRADIATION ON THE PERMEABILITY OF THE BLOOD AND BRAIN BARRIER FOR 5-HYDROXYTRYPTAMINE IN NORMAL AND ADRENALECTOMIZED RATS. Bulat, Marin; Supek, Zlatko; Deanovic, Zivan (Inst. Rudjer Boskovic, Zagreb). Int. J. Radiat. Biol., 11: 307-10 (1966).

Variations in the rat brain content of 5-hydroxytryptamine (5-HT) following x-irradiation have been reported. An increase occurred following doses of 8000 and 12,000 R. Lower doses, (900 R) induced this effect only in adrenalectomized rats. The effect of x-irradiation on the permeability of the blood-brain barrier for 5-HT in normal and adrenalectomized rats was studied by measuring the brain content of rats killed 10 min after being injected with 5-hydroxytryptamine creatinine sulphate into a tail vein. No difference in brain content of 5-HT of injected rats was noted between irradiated (900 R or 8000 R) or non-irradiated animals. Similar results were obtained in normal and adrenalectomized rats. The 5-HT content appears to be a consequence of the direct effect of x-irradiation on the central nervous system and is not due to any change in permeability of the cerebral capillaries for 5-HT. (TSS)

10732 LOCALISATION OF RADIOIODINATED ENDOTOXIN IN ORGANS OF MICE AND RABBITS: EFFECT OF THOROTRAST, TRYPAN BLUE, ENDOTOXIN, AND CARBON ADMINISTERED INTRAVENOUSLY. Fisher, S. (Royal North Shore Hospital of Sydney, New South Wales). Nature, 213: 511-12 (Feb. 4, 1967).

The splenic uptake of intravenously introduced sheep erythrocyte stroma in mice is increased if certain finely divided agents (such as carbon, Trypan blue, saccharated iron oxide, thorotrast, polystyrene latex) are injected by the same route simultaneously or before administration of the stroma. The present communication describes a study of the distribution of endotoxin in animal organs under similar conditions. The effect of Trypan blue and of thorotrast on the splenic and hepatic uptake of ^{131}I-labeled endotoxin was examined in rabbits, and the effect of thorotrast and of unlabeled endotoxin in mice. Uptake of ^{131}I was consistently higher than in controls, particularly by the spleen. Studies were also made on uptakes by other organs and tissues. The experiments reported suggest that the more severe effects of endotoxin in rabbits previously treated with the foregoing agents were caused not by reduced uptake of endotoxin by reticuloendothelial organs, but by increased uptake and delay in disposal of the toxin in the liver and spleen. The findings may be relevant to the Shwartzman reaction. (auth)

10733 ERYTHROPOIESIS AND COBALT. 2. STUDIES ON ERYTHROPOIESIS STIMULATING MECHANISM OF COBALT. Matsumoto, Shuichi (Gunma Univ., Kiryu, Japan). Nippon Ketsueki Gakkai Zasshi, 28: 698-708(Nov. 1965). (In Japanese).

It is well known that cobalt has an activity that stimulates erythropoiesis in vivo, although the underlying mechanism still remains unclear. In order to elucidate the nature and action of the erythropoiesis stimulating activity of cobalt, experimental studies were performed in rabbits and rats. Daily intramuscular injection with 0.075 mole $CoCl_2$ solution for 29 days at a dose rate of 1 ml/kg of body weight on the first day and 0.5 ml/kg body weight on the other days, resulted in a sustained increase in reticulocyte count. Red cell count increased to 8 to 11.5 million/cmm on the 29th day from the initiation of the daily injection. Utilization of ^{59}Fe injected on the last day of the daily Co injection was evidently accelerated as compared to that value obtained in control rabbits injected with normal saline. No remarkable change was observed in urinary excretion of coproporphyrin throughout the treatment period with $CoCl_2$ solution. Erythropoietin activity was elevated in plasma obtained on the 4th day from the initiation of daily injection with $CoCl_2$ solution. Daily injection with cobalt solution at the same dose rate used in rabbits resulted in an acceleration of ^{59}Fe utilization in rats. In bilaterally nephrectomized rabbits, acceleration of ^{59}Fe utilization was not observed. From these results, it is concluded that cobalt does stimulate erythropoiesis through erythropoietin production in the kidney. (auth)

10734 CHANGES IN THE EFFECT OF DIGITALIS AFTER IRRADIATION. Vokrouhlicky, L.; Jurkovic, V.; Fiala, J.;

Sanda, Z. Jr. (Charles Univ., Hradec Kralove, Czechoslovakia). Cesk. Fysiol., 15: 421(Sept. 1966). (In Czech).

The reaction of the heart digitalis after irradiation was investigated. Experiments were conducted on rabbits 6 days after irradiation with 1000 R, administered either on the whole body or locally on the heart region and the head. A dose of 0.08 mg/kg of Lantoside C was administered i.v. The occurrence of temporary and agonal arrhythmias was reduced by irradiation. The findings did not differ from each other irrespective of which part of the body (heart region, head, or whole body) was irradiated. The effect is explained by a change in the reactivity of the CNS caused by irradiation. (JPRS)

10735 STUDIES ON THE METABOLISM OF THIAMINE IN THYROID DISORDERS. (2). METABOLISM OF THIAMINE-^{35}S IN RABBIT. Ogawa, Ryuzo (Kyoto Univ.). Bitamin, 33: 318-24(Mar. 1966). (In Japanese).

The distribution of ^{35}S was studied in urine and organs of rabbits after an intravenous injection of ^{35}S-thiamine. Urinary ^{35}S-compounds were fractionated into thiamine and its metabolites by paper chromatography. About 40% of the administered ^{35}S was found in liver 30 min after injection. In testes, heart, and brain, ^{35}S contents at 3 hrs after injection were a little higher than those at 30 min after, while in lung and muscle, it decreased with time. Thiamine and ^{35}S in plasma increased promptly after injection and disappeared with the lapse of time. Thiamine content measured by thiochrome method was higher than that calculated from ^{35}S distribution until 1 hr after injection, then it decreased more rapidly. In urine ^{35}S was fractionated in various fractions, such as thiamine, thiochrome, 4-methyl-5β-hydroxymethylthiazole, 4-methyl-5-carboxymethylthiazole, and unknown substances. Sulfur-35 was also detected in bile. Percentages of urinary ^{35}S to administered dose during a period of 30 min, 3, and 5 hrs after injection, were about 35, 46, and 68, respectively. It was revealed that about 54% of ^{35}S excreted in 5 hrs in urine was in the thiamine molecule, while the remainder was in its metabolites, indicating that about one-half of thiazole moiety degradated. (auth)

10736 MEASUREMENT OF BLOOD FLOW BY EXTERNAL MONITORING OF RADIOISOTOPES. Worsham, James E. Jr. (Medical Coll. of Virginia, Richmond). J. Appl. Physiol., 21: 1653-4(Sept. 1966).

Equations for measuring average blood flow per unit volume as developed by Zierler (Circulation Res., 26: 309-21(1965)) are modified to permit the measurement of the volume of distribution of a radioactive indicator. One experiment suggested by Zierler is shown to be incorrect. Zierler suggested that a constantly accelerated input could be conveniently achieved by the injection of a nonmetabolized, noneliminated indicator into a vein. The resulting integration of this input in the total-body circulation would yield a constantly accelerated input to every organ in the body and this acceleration could be determined by arterial sampling at any point. This is not true. Although arterial sampling will give the concentrations of indicator entering any organ, the needed quantity, amount of indicator entering the organ per unit time, can be had from arterial concentration only if the flow is known. The experiment in which one measures the input concentration rather than the input amount per unit time measures only the volume of distribution of the indicator. To measure average flow per unit volume it is emphasized that one needs to know the actual amount of indicator entering the volume per unit time, a sometimes more difficult measurement than simply input concentration. (BBB)

10737 FIXING OF FALLOUT MATERIAL BY FLOATING MARINE ORGANISMS, SARGASSUM FLUITANS AND S. NATANS. Angino, Ernest E.; Simek, John E.; Davis, Jim A. (Texas A and M Univ., College Station). Pub. Inst. Marine Sci., Univ. Tex., 10: 173-8(June 1965).

Gamma spectrometry studies in October, 1963, of Sargassum fluitans and S. natans, a free floating marine algae common to the Caribbean area, indicated concentration of several radionuclides. The samples were ignited at 400 to 500°C for 4 hr, cooled, and then compressed into $\frac{1}{8}$ by 2 in. dia aluminum planchets for counting by a 256-channel analyser with a 3 by 3 in. dia NaI(Tl) crystal. Spectra for 0 to 2.5 MeV were scanned in 5 energy intervals; namely 0 to 0.2, 0.2 to 0.4, 0.4 to 0.6, 0.6 to 1.4, and 1.4 to 2.5 MeV. Net counts per unit time per energy interval were compiled to give the full spectrum of 0 to 2.5 MeV for each sample. Owing to the time interval since the last atmospheric tests, only those isotopes whose half-life exceeds 30 days were considered in peak identification. Of these ^{95}Zr, ^{144}Ce-^{144}Pr, ^{137}Cs, ^{103}Ru-^{103}Rh, ^{106}Ru-^{106}Rh, and ^{54}Mn were detected. Other radionuclides were strongly indicated, but not positively identified. Inasmuch as the Z of none of the isotopes identified exceeds 82, it is clear that the activity present cannot be attributed to the natural radioactivity known to exist in a normal marine environment. (BBB)

10738 CONTENTS OF FREE AMINO ACIDS ADJACENT TO THE TRICARBOXYLIC ACID CYCLE IN BRAIN UNDER X-RAYING. Pikulev, A. T.; Dovgolevich, I. I. (Belorussian State Univ. Inst. of Physiology, Academy of Sciences, Belorussian SSR). Dokl. Akad. Nauk BSSR, 10: 789-91(Oct. 1966). (In Russian).

The effects of a 40 R dose of whole-body x radiation on the content of alanine, aspartic acid, and glutamic acid in the brain of rats were studied. Following irradiation the content of amino acids varied from pre-irradiation levels. The amount of aspartic acid increased during the first post-irradiation day, with a second rise on the 15th day; glutamic acid was reduced from the first through the 7th day; and alanine content remained the same during the first days but increased on the 7th and 15th days. The results differ from published data on rats irradiated with 500 R. (R.V.J.)

10739 THE METABOLISM OF ^{137}Cs IN DAIRY COWS. Sansom, B. F. (Agricultural Research Council Inst. for Research on Animal Diseases, Compton, Eng.). J. Agr. Sci., 66: 289-93 (June 1966).

Radioactive fallout contains more cesium-137 than strontium-90. During 1961, in the United Kingdom, the average human diet contained six times as much ^{137}Cs as ^{90}Sr and in 1962 and 1963 this ratio had increased to about 15. Most of this, between 70 and 90%, is contributed by dairy products and meat. Thus, information on the transfer of ^{137}Cs from the diet of cows to their milk and meat is needed. The metabolism of ^{137}Cs in dairy cows was studied after single oral and intravenous doses and during twice daily oral dosing for 28 days. Gastrointestinal absorption of ^{137}Cs was about 70 to 80% of the oral doses. After 28 days continuous feeding the mean concentration of ^{137}Cs in milk was 0.84% daily dose/liter, and the body burden of the isotope varied between 5.7 and 8.2 times the daily intake. When feeding of ^{137}Cs stopped, the concentration of the isotope in milk fell by a factor of 5 in 8 days, by a factor of 10 in 16 days, by a factor of 20 in 32 days, and thereafter exponentially with a half-life of 30 days. The concentrations of the isotope in muscle decreased at first slowly but finally also exponentially with a half-life of ~30 days. In its secretion into milk ^{137}Cs behaves similarly to potassium but the relative importance of the urinary and fecal excretory routes for ^{137}Cs are reversed as compared with potassium. (BBB)

10740 SOME DATA ON PENTOSE-PHOSPHATE CYCLE DURING ACUTE RADIATION SYNDROME IN DOGS. Trebukhina, R. V. Radiobiologiya, 6: 766-8(1966). (In Russian).

The transketolase activity of the blood and the ferment system of the pentose conversion were investigated in dogs exposed to whole-body x radiation at doses of 770 R. The level of the pyruvic acid in the blood was also determined. The results are shown graphically as a function of the days after irradiation. (J.S.R.)

10741 ELIMINATION OF ^{90}Sr AND CALCIUM FROM THE BODIES OF DOGS. Sarapultsev, I. A. Radiobiologiya, 6: 704-7 (1966). (In Russian).

^{90}Sr, after subcutaneous injection, was eliminated from the bodies of dogs with 4.3 ± 1.4% in the urine, 15 ± 3% in the feces, and 1.4 ± 0.1% through the skin and ^{45}Ca was eliminated with 0.9 ± 0.4%, 11.7 ± 3%, and 1.0 ± 0.1%, respectively. In the blood-urine chain, the discrimination coefficient of ^{90}Sr with respect to Ca is 5 and in the blood-skin chain 1.4. The ^{90}Sr concentration in the animal organism after single injection of the isotope can be determined from the activity of the urine with knowledge of the regularity of the change of the ratio of the activity of the urine and the activity of the organism with time. (tr-auth)

10742 ANTIBODIES TO LYSATE OF AUTOERYTHROCYTES IN RATS BY CHRONIC INFLUENCE OF SOME RADIOACTIVE BIOELEMENTS. Alekseeva, O. G. Radiobiologiya, 6: 708-11 (1966). (In Russian).

Antibodies to lysate of autoerythrocytes were detected by the Uan'e method in a significant fraction of the animals in the first phase of radiation effects after 2 weeks and 9 to 12 months after discontinuation of the chronic enteral introduction of radioactive bioelements (^{35}S, ^{45}Ca, and ^{54}Mn). The increase of the autoantibodies was not correlated with the presence and expression of chronic radiation sickness and the total dose of absorbed energy but evidently, depends on the local radiation of the bone marrow. (tr-auth)

10743 ROLE OF QUINONES IN DEMONSTRATION OF IRRADIATION EFFECTS. Kuzin, A. M.; Norbaev, N.; Parpieva, G. (Inst. of Biological Physics, Moscow). Radiobiologiya, 6: 728-30(1966). (In Russian).

The dose and time factors of the accumulation of quinone in leaves, stems, and roots of irradiated seedlings of cotton were

obtained. Quinones, formed in leaves during local irradiation, quickly begin to move and appear in the shielded stems and roots. The movement of the quinones was shown during local irradiation of roots by their quantitative determination in shielded stems and leaves. In agreement with the data obtained, the remote effects of radiation in plants can be completely explained by the rapid movement of quinones (radiotoxins) from the site of irradiation to remote parts of the plant. (tr-auth)

10744 CHANGES OF RESERVOIR OF FREE AMINO ACIDS IN LIVER AND SPLEEN OF RATS BY IRRADIATION AND INJECTION OF RADIOPROTECTORS. Belavina, L. P.; Blokhina, V. D.; Romantsev, E. F. Radiobiologiya, 6: 724-7(1966). (In Russian).

The effect of the injection of β-mercaptopropylamine on the radioinduced changes in the reservoir of free amino acids in the liver and spleen was investigated in rats exposed to γ irradiation of $LD_{95/30}$ 10 min. after the injection. The results showed that the injection of the propylamine affects the level of amine nitrogen and the concentration of free amino acids, especially in the spleen, where the greater amount of the propylamine is accumulated. The significance of the reduction of the levels of the amine nitrogen and free amino acids after combined treatment with the propylamine and irradiation was discussed. (J.S.R.)

10745 INFLUENCE OF IONIZING RADIATION OF DIFFERENT INTENSITY ON C_6H_5OH FORMATION IN EXPERIMENTAL ANIMALS. Fridlyand, I. B. Radiobiologiya, 6: 751-3(1966). (In Russian).

The irradiation of male rats with the RUM-3 device or the 25-MeV betatron causes disturbances of the phenol exchange. In the first day after irradiation at high doses, the formation of phenol decreases and even ceases completely, but with time it increases. The maximum quantity of phenol, excreted by sick rats, exceeds by 10 to 30 times the quantity excreted by healthy rats. In radiation sickness in the rats, the formation of phenol in the urine is subjected to periodic oscillations, reflecting, possibly, the phase pattern of the illness. (tr-auth)

10746 PROBLEM OF ACCELERATION OF ^{90}Sr ELIMINATION FROM THE BODIES OF MAMMALS. Annenkov, B. N. Radiobiologiya, 6: 753-4(1966). (In Russian).

The effects of separate and combined application of ammonium chloride, magnesium sulfate, and calcium gluconate on the elimination of ^{90}Sr from the bodies of mammals at early and delayed periods of strontium poisoning were studied. The tests were made on rats. The results showed that the daily intraabdominal injection of ammonium chloride for 5 days does not affect the retention of ^{90}Sr in the animal. The results of tests on calcium gluconate and magnesium sulfate, introduced separately or in combination with each other or with ammonium chloride were tabulated. The most effective agent for the acceleration of the ^{90}Sr elimination was magnesium sulfate. (J.S.R.)

10747 ELIMINATION OF RADIOACTIVE BERYLLIUM FROM THE ORGANISM UNDER THE INFLUENCE OF COMPLEXING COMPOUNDS. Arkhipova, O. G.; Zeltser, M. R.; Petushkov, A. A. Radiobiologiya, 6: 754-5(1966). (In Russian).

The effects of the aminoalkylphosphonic acids (disodium salt of ethylenediaminobisisopropylphosphonic acid) (phosphitsin), calcium-sodium salt of diethylenetriaminpentamethylphosphonic acid (DTPP), and ammonium salt of aurintricarboxylic acid (ATA) on the distribution and elimination of radioactive beryllium were investigated. The salts were introduced intraabdominally into white mice and rats at different doses and various times after the uptake of ^{7}Be. The results showed that a single injection of the complexing compounds caused a significant reduction of the γ activity of the tissues. Phosphitsin and DTPP accelerated the elimination of the ^{7}Be from the body and reduced its concentration in the organs. The efficiency of the preparations depends on the time of their introduction. Repeated injections of the preparations were the most effective. (J.S.R.)

10748 SOME METHODIC PECULIARITIES OF MICROELECTROPHYSIOLOGICAL INVESTIGATION UNDER EXPOSURE TO RAYS. Nadareishvili, K. Sh. Radiobiologiya, 6: 693-6(1966). (In Russian).

Some variants of the scheme for investigation of microelectrophysiological phenomena under radiation effects were studied. A circuit with balanced input cascade on the electrometer of the EM4 triode type is given. The characteristics of the circuit are given. (J.S.R.)

10749 EXPERIMENTAL INVESTIGATION ON THE ACCUMULATION OF RADIOISOTOPES BY FRESH WATER BIOTA. Garder, Karen; Skulberg, Olav (Inst. for Atomic Energy, Kjeller, Norway). Acta Hydrobiol., 62: 50-69(May 1966).

Because increasing volumes of low level concentrations of radioactive waste are being introduced into lakes and rivers, the accumulation of radionuclides by biotic and abiotic media of an aquatic environment was investigated experimentally at a hydrobiological field station. The experiments were performed with water from the River Nitelva, located in the southeastern part of Norway. The radionuclides studied were ^{32}P, ^{137}Cs, ^{144}Ce, ^{89}Sr, ^{103}Ru, and $^{95}Zr-^{95}Nb$. Accumulation of these radionuclides by sediments, algae, vascular plants, invertebrates, and fish was investigated. Concentration factors for the various radionuclides in the experimental species are tabulated. The importance of monitoring inland waters is discussed. (TSS)

10750 EFFECT OF X RAYS IN VIVO ON THE PENTOSE CYCLE OF ERYTHROCYTES. Sonka, J.; Malina, L.; Pospisil, J.; Dienstbier, Z. (Charles Univ., Prague). Agressologie, 6: 205-12(Mar.–Apr. 1965). (In French).

The effect of sublethal doses of x rays on enzyme activities of the pentose-phosphate cycle in red cells was studied in various animals. The assay method used depended on the increase of ribose concentration and decrease in glucose level in glucose-containing buffer containing erythrocytes. Dogs were given whole-body 600-R doses of x rays and red cells sampled 1 to 29 days later. In guinea pigs exposed to 700 R an immediate decrease in activity of the cycle was noted which was not accompanied by a marked decrease in ribose formed, indicating a decrease in glycolysis also. In rats exposed to 800 R a drop in both ribose formation and pentose cycle activity was seen. In rats this was accompanied by a 40% decrease in glutathione formation and a 25% decrease in adenosinetriphosphate. This was shown not to be accompanied by an inhibition of oxidative phosphorylation. (BBB)

10751 INTERMOLECULAR REACTIONS IN THERMAL INACTIVATION OF IRRADIATED TRYPSIN SOLUTIONS. Luzikov, V. N.; Troshkina, T. V. (Moscow State Univ.). Radiobiologiya, 6: 641-5(1966). (In Russian).

The extent of the inactivation processes of natural trypsin with hydrogen peroxide depends on the concentration of the peroxide, and concentration of the albumin in the solution and does not depend on the temperature in the interval from 70 to 96°. This process has an activation energy comparable to the activation energy of thermal reactions in trypsin solutions irradiated with x rays. The inactivation of trypsin with other "toxic products" of the radiolysis of its solutions is characterized by the fact that the extent of the process is decreased with decreased temperature. The conditions in which the thermal reactions could be examined as inactivation processes of cryptodamaged molecules of the ferment were determined. Data on the nature of the "toxic products" formed during the radiolysis of trypsin solutions were reported. (tr-auth)

10752 INFLUENCE OF SOME COMPOUNDS ON PHOTOCHEMILUMINESCENCE OF SERUM ALBUMIN SOLUTIONS. Sapezhinskii, I. I.; Dontsova, E. G. (Inst. of Physical Chemistry, Moscow). Radiobiologiya, 6: 646-50(1966). (In Russian).

The effect of 70 substances of different classes on the luminescence of bull serum albumin solutions was studied. It was shown that amino acids (with the exception of cysteine) and a series of peptides weakly affects the postluminescence. Sugars, alcohols, aldehydes, and ketones practically do not affect the kinetics of the continuous postluminescence. The expressed effect of a series of compounds from the phenol class on continuous postluminescence processes was established. Some radioprotective materials (cystine, mercamine, isothiouronic compounds, and sodium diethyldithiocarbamate) weakly affect the luminescence of irradiated albumin. The effect of some compounds on the postluminescence is connected with their reactions with peroxide free radicals of irradiated albumin and proposals are made for the possibility of using these processes as model processes. (tr-auth)

10753 ENERGETIC YIELD BY RADIOLUMINESCENCE OF TRYPTOPHAN. Barenboim, G. M.; Mochalkin, A. I. Radiobiologiya, 6: 671-4(1966). (In Russian).

The energy yield from the radioluminescene of tryptophan was theoretically and experimentally determined and the results were compared. (J.S.R.)

10754 ACTION OF PROPAMINE AND IRRADIATION ON PURINE COMPOUNDS SYNTHESIS. Khalikov, S. K.; Romantsev, E. F. Radiobiologiya, 6: 675-7(1966). (In Russian).

The prophylactic administration of β-mercaptopropylamine (MPA) against the effects of irradiation does not prevent the suppression of the synthesis of purine compounds (inosinic acid, inosine, and hypoxanthine) in the liver of pigeons, but in irradiated birds the capacity for regeneration of synthesis is maintained. This regeneration of synthesis begins within the third day after irradiation and within 12 days attains approximately 38% of the normal value. (tr-auth)

10755 OXIDATIVE PHOSPHORYLATION IN RAT LIVER MITOCHONDRONS AFTER IRRADIATION AND AGING OF MICROSTRUCTURES. Smirnova, T. N.; Romantsev, E. F. Radiobiologiya, 6: 678-81(1966). (In Russian).

After irradiation of rats with absolutely minimum lethal dose of γ rays a proved change of the P/O coefficient in fresh mitochondria of the liver during oxidation of succinic acid and pyruvic acid was not detected within 3 min., 1 hr., and 12 to 14 hrs. The capacity of liver mitochondria of non-irradiated rats for oxidation of succinic acid and combined absorption of inorganic phosphates increases in 30-min. preincubation. This process used as a substrata for the oxidation of pyruvic acid decreased after preincubation. The capacity of liver mitochondria of irradiated rats for the oxidation of succinic acid and combined absorption of inorganic phosphate increases after 30-min preincubation up to the same value as in the mitochondria of non-irradiated animals. In the case of the utilization of a substrate, the oxidation of pyruvic acid with 30-min preincubation the very sharply expressed oxidative phosphorylation in the liver mitochondria of irradiated animals approaches that of normal animals. It begins after 5 min of preincubation and is clearly shown after 30 min of aging within 30 min., 1 hr., and 14 to 24 hrs. after irradiation. (tr-auth)

10756 LIBERATION OF BRAIN 5-HYDROXYTRYPTAMINE AND NORADRENALINE BY X-RAY TREATMENT IN THE NEWBORN AND ADULT RAT. Palaic, D. (Cleveland Clinic Foundation); Supek, Z. J. Nurochem., 13: 705-9(Aug. 1966).

Effects of the age of animals, interrelation between the content of brain 5-hydroxytryptamine (5-HT) and noradrenaline (NA), and influence of some neuropharmacological agents on the release of the neurohormones by ionizing irradiation were examined. Newborn (1 to 6 days of age) and adult (4-month-old) rats were x-irradiated with 900 R. Whole brain of newborn rats contains less 5-HT and NA than adult brain. Immediately after irradiation, which lasted 11 min, brain NA content was decreased but 5-HT content was unchanged. At 3 hr after irradiation a significant decrease of both 5-HT and NA was observed. At 24 hr NA content showed complete recovery but the 5-HT content was still subnormal. In experiments with adult rats the release of the neurohormones was retarded compared to newborn rats. A decrease of NA was observed earlier (3 hr after irradiation) than a decrease of 5-HT (24 hr after irradiation). Pretreatment of newborn rats with chlorpromazine or iproniazid decreased significantly the content of NA but did not affect the concentration of 5-HT. On the other hand, both of these drugs fully prevented the fall of the brain 5-HT after irradiation but did not block the decrease of NA. Chlorpromazine did not significantly alter the level of 5-HT and NA in the brain of adult rats. Iproniazid increased the content of both neurohormones. A significant increase of brain 5-HT was noted in irradiated adult rats injected with iproniazid or chlorpromazine before irradiation. The radiation-induced fall of NA failed to occur in animals pretreated with iproniazid. The results show the differences in radiosensitivities of the NA and 5-HT pools in the brain. (BBB)

10757 COMPARISON OF THE AFFINITY OF ^{15}O AND ^{16}O TO HEMOGLOBIN. Asakura, Toshio; Yoshikawa, Haruhisa; Iio, Masaaki; Baba, Harukata; Karasawa, Takashi (Tokyo Univ.). J. Appl. Physiol., 21: 1091-3(May 1966).

Studies were undertaken to verify or disprove an earlier report that ^{15}O and ^{16}O behave differently in respiration studies. Oxygen-15 was prepared by the (d,n) reaction from ^{14}N by the continuous-flow method in a 26-in. cyclotron. The process employed was the same as that reported earlier except that the gas was bombarded through a thin nickel-foil window and not through aluminum foil. When an aluminum window was used, it was found that ^{28}Al was produced as a by-product and was thought to interfere with the experiments. No other radioactive contaminant than ^{15}O was detected. The ^{15}O was used for the determination of oxygen dissociation curves of hemoglobin using a Thunberg-type counting tube. A new method of isotopic measurement is described. The results were compared with those obtained from the usual spectrophotometric method. The oxygen dissociation curves and the Bohr effect of human hemoglobin, which were measured by the 2 methods, were similar within the experimental error. The results indicate that the affinity of ^{15}O can be used as a tracer of ^{16}O in studies of lung function and tissue respiration. (BBB)

10758 MAMMARY INSUFFLATION AND PASSAGE OF RADIOACTIVE CALCIUM FROM THE MILK TO BLOOD. Manunta, Giovanni; Marongiu, Antonio; Nuvole, Paolo (Univ., Sassari, Italy). Arch. Vet. Ital., 14: 325-40(Aug. 31, 1963). (In Italian).

Passage of a radioisotope from the milk to the bloodstream was demonstrated. Ten lactating sheep were used. One udder of two animals was injected via the teat canal with 30 μC of ^{45}Ca as $CaCl_2$ in 10 ml saline. Four sheep received ^{45}Ca as above: in two subjects the treated udder was air inflated, in two others the untreated udders were also air inflated. The cistern of two sheep, before the inflation, was filled with ^{45}Ca-labeled milk secreted by two other animals previously dosed with 50 and 200 μC of ^{45}Ca respectively. Systematically, samples of blood and milk were taken and the ^{45}Ca in urine, in fecal excreta, and in bone was determined. The passage of ^{45}Ca from milk to blood was low, except when the treated udders were inflated; in this case the radioactivity present in blood was easily demonstrable 5 min after the insufflation, reached a maximum after 30 to 60 min then dropped. The amount of ^{45}Ca passing from udder to blood under such conditions can attain 90% of the administered dose. The inflation of the untreated udders interfered with the ^{45}Ca secretion in milk. The ^{45}Ca of milk was demonstrable 9 days after dosing. After ^{45}Ca-labeled milk infusion, via the teat canal, and inflation a considerable amount of ^{45}Ca moved into bloodstream, deriving from the ionized and nonionized ^{45}Ca of milk. (BBB)

10759 STUDIES OF IRON METABOLISM IN CHILDREN WITHOUT THE USE OF RADIOACTIVE ISOTOPES. Rind, H.; Gladtke, E.; Dost, F. H. (Univ., Giessen, Ger.). German Med. Mon., 10: 397-401(Oct. 1965).

Iron metabolism was studied in children by a new method that avoids the use of radioisotopes and the associated consequent hazards. Results with the new method were compared with those obtained by the use of radioisotopes. The method depends upon disturbance of the steady-state concentration of ^{56}Fe by injection of ^{56}Fe. Intravenous loading was performed by injecting 70 μg of iron per kg of body weight intravenously. Before and at appropriate time intervals after the injection, serum iron levels were estimated by the bathophenanthroline method, using capillary blood. The labile pool roughly paralleled the serum iron level. It was high during the first 60 days of life, fell distinctly until the end of the first year and reached a constant level during the second year. Corresponding to the low serum iron levels during the fourth to sixth months of life in premature infants, the labile pool showed distinctly lower values in comparison with full-term infants during this period, whereas practically no difference existed during the first two months of life. The turnover rate rose to a max during the first month of life and then dropped markedly until the second trimester. During the third trimester it rose again and in the second year attained the same levels as for the plasma-iron turnover rate in adults. In premature infants the transfer was slightly lower in the first month and attained the lowest levels we have observed in the second trimester. (BBB)

10760 ISOTOPIC COMPOSITION OF ORGANIC CARBON FROM MARINE PLANKTON AND ITS RELATION TO MARINE SEDIMENTS. Sackett, William M. (Univ. of Tulsa, Okla.); Eckelmann, Walter R.; Bender, Michael L.; Be, Allan W. H. Erdoel Kohle-Erdgas-Petrochem., 19: 562-4(Aug. 1966). (In German).

The $^{13}C/^{12}C$ ratios were determined for some plankton samples from the Atlantic and Pacific Oceans and compared to the $^{13}C/^{12}C$ ratios for atmospheric CO_2, marine plants, marine lipids, terrestrial plants, and terrestrial lipids. The results showed that marine plankton, collected where surface water temperatures are about 25°C, are enriched in ^{13}C compared to samples from high latitude areas of the South Atlantic where water temperatures are near 0°C. This may be due to a greater carbon isotope fractionation at lower temperatures during the initial fixation of inorganic carbon by photosynthesis and/or a specific biological selection. This effect may result from biological differences causing isotopically lighter carbon to be selectively retained by cold water organisms rather than by warm water organisms. Thus it appears that the isotopic carbon composition of marine organic sediments can be controlled by 2 major factors: the amount of terrestrially derived organic carbon and the amount of cold or warm water marine plankton preserved in the sediments. (BBB)

10761 TOTAL ACTIVITY AND ISOZYME PATTERN OF LACTIC DEHYDROGENASE IN THE ORGANS AND SERUM OF ALBINO RATS IRRADIATED WITH 800 R DURING PREGNANCY, AS FETUSES, AND AS ADULT NONPREGNANT RATS. Goetze, T.; Goetze, E. (Friedrich-Schiller-Univ., Jena, Ger.). Acta Biol. Med. Ger., 16: 337-49(1966). (In German).

Further evidence was sought of the apparent enzyme radioinsensitivity in adult and fetal Wistar rats. At 24 hr after a whole-body irradiation with 800 R, there was no significant variation of lactic dehydrogenase (LDH) activity from controls in heart and skeletal muscle, kidney, liver, and lung of pregnant rats and their fetuses despite great individual differences. No change of LDH activity in the maternal spleen and placenta was seen after irradiation, but it was increased in fetal serum. At 24 hr and, in particular, at 48 hr after irradiation of adult nonpregnant rats, the activity rose slightly in all organs studied, except in spleen and in serum. LDH activity of the organs of unirradiated adult nonpregnant rats was always lower than that of pregnant animals.

An investigation of the ontogenetic variations of the LDH isozyme pattern in the various organs and serum after x-irradiation of fetal animals revealed a more rapid adaptation to the isozyme distribution pattern of adult animals than in unirradiated controls. There were more isozymes in the serum of x-irradiated adult and fetal rats than could be demonstrated under normal conditions. (TSS)

10762 IN VIVO INTESTINAL ABSORPTION OF L-ALANINE IN IRRADIATED RABBITS. Mehran, A. R.; Blais, R. (Laval Univ., Quebec). J. Nutr., 89: 235-40(June 1966).

Intestinal absorption of L-alanine was compared in control rabbits and rabbits exposed to 300 and 600 R of γ radiation (^{60}Co). Absorption of L-alanine was studied by an in vivo technique permitting measurement of radioactivity in a large number of blood samples taken from the portal and femoral veins of rabbits following duodenal injection of 20 μC of L-alanine-^{14}C. The experiments were carried out 4 days after irradiation. A rapid rise and fall of activity in the portal vein was seen under all 3 experimental conditions (control, 300 R, and 600 R). Absorption was practically completed 50 min after the injection of the amino acid. Absorption trends were similar and no significant difference was observed between those of irradiated and unirradiated animals. At the doses used, histological examination 4 days after irradiation showed only slight effects on the absorbing cells of the intestine. (BBB)

10763 TRUE CHOLINESTERASE IN VEINS AND ARTERIES IN RABBITS SUBJECTED TO WHOLE-BODY IRRADIATION. Calzavara, F.; Romani, S.; Zacchi, C. (Univ., Padua). Quad. Radiol., 28: 565-73(Sept.-Oct. 1963). (In Italian).

The activity of true cholinesterase was estimated by a histochemical method in the walls of arteries and veins of rabbits given daily 10-R whole-body doses of 220-kv x rays. The animals were examined at 0 and 15 days after total doses of 10, 30, 50, 110, or 160 R had been reached. The Gomori method employing myristoylcholine was used for enzyme assay. In general, the enzyme activity was decreased in a dose-dependent way. The most marked decrements were noted with the 110- and 160-R doses. After 160 R, the reaction was usually negative in femoral, jugular, and pulmonary vein, aorta, and carotid artery. After 15 days the activity was usually near normal except after the 160-R dose. It was found that local lead shielding could prevent the postirradiation drop in enzyme activity. The inhibition of this enzyme by irradiation may be related to the vasodilatation phase seen in irradiated animals. The recovery time of activity in the vascular walls appeared to be inversely related to the dose of radiation used. (BBB)

10764 SULFUR ISOTOPE FRACTIONATION BY SALMONELLA SPECIES. Krouse, H. R.; McCready, R. G. L.; Husain, S. A.; Campbell, J. N. (Univ. of Alberta, Edmonton). Can. J. Microbiol., 13: 21-5(1967).

A number of Salmonella species are capable of fractionating sulfur isotopes during sulfite reduction under aerobic and anaerobic conditions. The product H_2S may be enriched in ^{32}S by over 3% as compared to the initial sulfite $^{32}S/^{31}S$ composition. This is significantly higher than the isotope effect realized in the equivalent inorganic chemical reduction. (auth)

10765 INFLUENCE OF POLYPHOSPHATES ON RETENTION OF RADIOACTIVE STRONTIUM IN RAT AND MOUSE. Bates, T. H.; Smith, H. (United Kingdom Atomic Energy Authority, Annan, Scotland). Nature, 212: 925-6(Nov. 26, 1966).

Rats and mice were injected intraperitoneally with strontium-85. Polyphosphates were injected simultaneously into rats in doses such as to produce extracellular fluid concentrations equivalent to those required to inhibit nucleation on collagen in vitro. A double dose of the phosphate was injected 7 days later. The retention curve of the treated groups did not differ significantly from the mean curve for the controls. When hexametaphosphate was given for 2 days before the strontium-85 and again simultaneously with the isotope, enhanced excretion occurred 2 days after injection of the strontium-85. Sodium tripolyphosphate in the drinking water was administered to mice for 10 days before injecting the isotope and was continued thereafter. The uptake of strontium-85 was inhibited. (H.L.W.)

10766 FUNCTIONAL AND MORPHOLOGICAL CHANGES IN RAT KIDNEYS AFTER LOCAL IRRADIATION. Kaercher, Karl Heinz; Schulz, G. (Univ., Heidelberg). Strahlentherapie, 131: 395-407(Nov. 1966). (In German).

One or both kidneys of white inbred rats were irradiated with 1,000 R. The concentration of the enzymes LAP, MDH, and LDH in urine and serum was determined. Moreover, histological, histochemical, and quantitative biochemical evaluations of the kidneys were done. A single irradiation with 1,000 R of one or both kidneys caused distinct functional disturbances. They were found to be reversible after irradiation of only one kidney; when both kidneys were irradiated, however, a permanent damage could result. A change in the permeability of the tubular epithelium for the enzyme molecules mentioned above might be the cause for the quantitative changes in the kidney function. (auth)

10767 INCORPORATION OF SUBCUTANEOUSLY ADMINISTERED ^{59}Fe BY MOUSE ERYTHROCYTES. Thomson, R. A. E. (Univ. of Rochester, N. Y.). Nature, 212: 925(Nov. 26, 1966).

Iron-59-labeled citrate was injected subcutaneously into female mice. Twenty-four hours later the incorporation of iron into red blood cells was determined by measuring the radioactivity in 0.2 cc of blood obtained by cardiac puncture. The hematocrit was determined on the sample of cardiac blood. The value obtained compared favorably with results using intravenous or intraperitoneal techniques. The mean uptake of ^{59}Fe was 27.21% of the subcutaneously administered dose. (H.L.W.)

10768 INCREASED RADIOSENSITIVITY IN LENS ESCULENTUM SEEDS IRRADIATED IN A MONONUCLEOTIDE SOLUTION. Aguilera, A.; Colombara, E.; Pieber-Perreta, M.; Toka, C. J. (Univ. of Chile, Santiago). Nature, 213: 176-8 (Jan. 14, 1967).

It was known from previous work that it is possible to incorporate a mononucleotide into a polynucleotide by means of γ radiation. Two groups of seeds were incubated in water and in a solution of uridylic acid and ^{137}Cs-irradiated at 200 R/min to a total dose of 6×10^4R. Together with control groups, the irradiated seeds were planted on wet filter paper and the number of roots and cotyledons counted daily. From the data obtained it was inferred that greater cell damage occurred in the uridylic acid treated seeds, and it is postulated that this is a consequence of the incorporation of nucleotide into the cellular DNA or RNA. Damage of the DNA is the more likely. (UK)

10769 COMBINED EFFECTS OF CYTOTOXIN AND X RAYS ON BONE MARROW. Maisin, H. (Univ., Louvain, Belg.). Compt. Rend. Soc. Biol., 160: 1104-8(1966). (In French).

Cytotoxins do not potentialize the action of x rays on bone marrow. Alkylating agents add something to their effect, antimetabolites produce a certain form of enhancement; utilization is the same as that of microbial or vegetal cytotoxin, but the substance never gives potentialization. To obtain a significant response of long duration to a combination of cytotoxin and x rays it is necessary to associate the cytotoxin only once for three irradiations. (tr-auth)

10770 INFLUENCE OF THE PHYSICAL DECAY OF A RADIOACTIVE TRACER ON THE RESOLUTION OF A COMPARTMENTED SYSTEM. Perrault, G.; Bazin, J. P.; Pages, J. P. (CEN, Fontenay-aux-Roses, France). Int. J. Appl. Radiat. Isotop., 18: 7-10(Jan. 1967). (In French).

It is shown that the correction of experimental values due to the physical decay of the radioactive tracer during the period of time under consideration cannot be carried out except under precise conditions and when the mathematical model being followed is known perfectly. (auth)

10771 ELIMINATION OF RADIONUCLIDES (INFLUENCE OF ISOTOPIC DILUTION ON EFFICIENCY OF DTPA). Altenstetter, Frank; Bohne, Felicitas; Catsch, Alexander (Kernforschungszentrum, Karlsruhe, Ger.). Strahlentherapie, 131: 361-70(Nov. 1966). (In German).

Experiments with rats show that isotopic dilution of ^{144}Ce and ^{91}Y exerts an influence on the distribution pattern of the radionuclides and impairs efficacy of the diethylenetriaminepentaacetic acid in removing the radionuclides, particularly from the liver. Both of these findings are explained by the formation of colloids in the physiological milieu. (auth)

10772 CHANGES IN NATURAL RADIORESISTANCE OF MICE AFTER EXPOSURE TO HYPOXIA FOR SEVERAL DAYS; SURVIVAL AND BODY WEIGHT. Tribukait, Bernhard (Karolinska Institutet, Stockholm). Strahlentherapie, 131: 371-83 (Nov. 1966). (In German).

Mice were exposed to hypoxia for 4 and 10 days, respectively, corresponding to oxygen pressure at 6000 m altitude. Following the exposure to hypoxia, the radiation sensitivity of the animals was significantly changed: the radiation sensitivity was increased 2 to 18 hours after exposure, it was decreased immediately as well as 24 to 72 hours after exposure, and returned to normal values 96 hours after exposure. Characteristic changes of the survival and of the body weight at different times following exposure to hypoxia were investigated and discussed in view of changes of the animals during and after hypoxia exposure. (auth)

10773 THE X-RAY INDUCED DEGRADATION OF VITAMIN B_6 DERIVATIVES IN SOLUTION. Nakken, Karl F. (Norsk Hydro's Inst. for Cancer Research, Oslo). Strahlentherapie, 131: 384-94(Nov. 1966).

When neutral solutions of pyridoxal-5-phosphate (PLP) were

flushed with N_2, O_2 or N_2O, the doses of x rays required to give equal number of molecules degraded had a ratio of 4:2:1. Vitamin B_6 (PLP, pyridoxine and pyridoxal) was found to be oxidized by OH and by N_2O^- radicals, whereas O_2^- radicals were inactive. From the yields of molecules degraded it follows that vitamin B_6 radicals formed as intermediates may participate in: (1) dimerizations involving position 6 of the pyridine nucleus (in an atm of N_2O, N_2 or O_2), (2) back reactions induced by hydrated electrons (in N_2 atm) or (3) reactions with oxygen, giving rise to cleavage of the pyridine nucleus. Oxidation in position 4 of PLP gave rise to trace amounts of 2-methyl-3,4-dihydroxy-5-pyridylmethylphosphoric acid. 4- and 5-pyridoxic acid and the corresponding lactones were not detected in the irradiated solutions, even after freeze-drying. (auth)

10774 TIME DYNAMICS OF CHANGES IN SPECIFIC AND RELATIVE SPECIFIC RADIOACTIVITY OF PHOSPHORUS OF INDIVIDUAL FRACTIONS OF RAT BRAIN PHOSPHOLIPIDS. Antonov, L. M.; Gasteva, S. V. (Pavlov Inst. of Physiology, Leningrad). Byull. Eksp. Biol. Med., 62: No. 9, 56-60(Sept. 1966). (In Russian).

The specific and relative specific radioactivity (SR and RSR) of individual fractions of rat brain phospholipids obtained by means of chromatographic separation on a silica gel column was determined 30 minutes, 1, 2, 4, 8, 24, 48, 72, and 120 hours after a subcutaneous injection of $Na_2H^{32}PO_4$. Within 48 hours of injecting ^{32}P the SP of fractions I (phosphatide acids and polyglycerophosphatides) and III (phosphoinositides) considerably exceeded the SR of other fractions. By the 120th hour the SR curves of fractions I, III, II (aminophosphatides) and IV (lecitins) practically merged. The SR curve of fraction V (sphingomyelins) was considerably lower than the SR curves of all other fractions during the entire period of investigation. The RSR of fractions II, IV, and V grew uniformly during 120 hours. The RSR curve of fraction I showed a sharp change in two hours, and the curve of fraction III in four hours after injection of ^{32}P. (auth)

10775 CHANGES IN THE OPTIC DENSITY AND VISCOSITY OF HEMOLYSATES UNDER THE ACTION OF ULTRAVIOLET LIGHT AND HEAT. Sivets, E. F. Byull. Eksp. Biol. Med., 62: No. 9, 63-5(Sept. 1966). (In Russian).

It was shown that ultraviolet radiation under conditions of the experiment increased the optic density and reduced the viscosity of primary hemolysates and also diminished the molecular weight of primary hemoglobin. The heating of primary hemolysates (at 58°C during 15 minutes) produced no significant change in the optic density and viscosity of hemoglobin. At the same time, hemoglobin fully retained its hydrophilic properties. The heating of irradiated hemolysates under identical conditions was accompanied by a tremendous increase in their optic density, intense dimness, and a sharp decline in viscosity. This was attended by a complete transformation of the state of hemoglobin from hydrophilic into hydrophobic, which evidenced an increase in the sensitivity of irradiated hemoglobin to the thermic factor. (auth)

10776 STUDIES ON BIOLOGICAL RADIATION PROTECTION. REPORT 76. ACTIVITY OF TRYPTOPHAN- AND KYNURENINE HYDROXYLASE IN MOUSE LIVER AFTER RADIATION IN VIVO AND EFFECTS OF 5-HYDROXYTRYPTAMINE ON THEIR ACTIVITY. Waldschmidt, Marianne; Pollak, Heinz; Streffer, Christian (Univ., Freiburg i. B.). Strahlentherapie, 131: 415-22(Nov. 1966). (In German).

Enzyme activities of tryptophane- and kynurenine-hydroxylase were measured in liver tissue of white mice 12 hours to 12 days after whole body irradiation with 690 R. A decrease of the tryptophane hydroxylase activity was observed. Compared with control animals which were kept without food for 24 hours before being killed, the decrease was very significant from the 6th to the 8th day after irradiation. The activity of kynurenine hydroxylase was not changed after irradiation. Prophylactic administration of 5-hydroxytryptamine inhibited the decrease of the tryptophane hydroxylase activity. The radiation influence on this enzyme is discussed in view of the biosynthesis of 5-hydroxytryptamine. (auth)

10777 STUDIES ON BIOLOGICAL RADIATION PROTECTION. REPORT 77. INFLUENCE OF 5-HYDROXYTRYPTAMINE ON RADIOINDUCED ENZYME CHANGES IN TRYPTOPHAN METABOLISM. Streffer, Christian; Langendorff, Hans-Ulrich (Univ., Freiburg i. B.). Strahlentherapie, 131: 453-60(Nov. 1966). (In German).

Enzyme activities of tryptophane-pyrrolase, kynurenine-aminotransferase, and kynureninase were measured in liver tissue of mice 12 hours to 12 days after injection of 5-hydroxytryptamine as well as after administration of the amine plus irradiation with 690 R. Injection alone had no influence upon the activities of tryptophane-pyrrolase and kynurenine-amino-transferase during the observation time mentioned; the activity of kynureninase was slightly decreased. Compared with non-irradiated controls, injection and additional irradiation caused an increase in the tryptophane-pyrrolase from the 4th to the 9th day after irradiation, while the kynurenine-amino-transferase was decreased at that time. Irradiation caused no change in the kynureninase activity of animals treated with 5-hydroxytryptamine. Results obtained are compared with those obtained after irradiation alone and discussed in view of a possible action mechanism of the amine as a radiation protective substance. (auth)

10778 RADIOINDUCED EXCRETION OF XANTHURENIC ACID IN RATS AND ITS EFFECT ON SEROTONIN AND HISTAMINE. Ladner, Hans-Adolf; Wollschlaeger, Gesine (Univ., Freiburg i. B. Univ., Mainz). Strahlentherapie, 131: 461-72 (Nov. 1966). (In German).

The effect of tryptophan concentration, radiation dose, and of the biogenic amines serotonin and histamine on the excretion of xanthurenic acid after whole body irradiation of white rats is reported. In the case of whole body exposure of rats with a LD_{50} dose, a concentration of at least 100 mg of tryptophan/animal/day over a period of 14 days seems to be necessary in order to increase the xanthurenic acid concentration in the urine between the 5th and 12th day after irradiation. Serotonin and histamine have a smaller influence upon the radiation induced xanthurenic acid excretion in rats than in mice. Comparative studies on radiation induced changes in the protein metabolism in humans and animals should be done. Using the acute radiation sickness and other diseases as examples, the relative value of the xanthurenic acid test for the discovery of a vitamin B_6 deficiency is discussed. (auth)

10779 AUTORADIOGRAM OF A LARGE SURFACE FOR THE STUDY OF FETAL IODINE METABOLISM. Medveczky, Laszlo; Lampe, Laszlo. ATOMKI (At. Kut. Intez.) Kozlem., 8: 256-9(Sept. 1966). (In Hungarian).

Macroautoradiograms were prepared from the sectioned surface of 14–29 day old embryos of rabbits. The dam was injected i.v. with 50 μC of ^{131}I isotope. The preparation of the flat surface took place as follows: (a) by hand sectioning, (b) by sawing the embryo embedded in plaster of paris, and (c) by sectioning the embryo frozen in aqueous solution of gelatin by means of sliding microtome. During exposure the preparation was bagged in a pouch made of thin plastic foil. Three light-sensitive films were used at the same time. The exposure took place in a refrigerator. (auth)

10780 EXTRATHYROIDEAL IODINE METABOLISM IN FETAL LIFE. Lampe, Laszlo; Kertesz, Laszlo; Dzvonyar, Janos; Ditroi, Ferenc; Medveczky, Laszlo. ATOMKI (At. Kut. Intez.) Kozlem., 8: 260-5(Sept. 1966). (In Hungarian).

The distribution of radioactive iodine (^{131}I) by rabbit experiments in maternal and fetal thyroid glands, in blood, amniotic fluid, placenta, and in certain fetal organs has been studied. The data of 92 pregnant doe-rabbits were elaborated 1, 2, and 24 hours after the injection of iodine isotope administered between the 12th and 30th day of pregnancy. The storage of iodine in the fetal thyroid gland begins on the 20th day and increases till delivery. During this period the thyroid gland synthesizes thyrosins and thyronins as well. This may be verified by a double isotope labeling (^{125}I and ^{131}I) and by two-dimensional paperchromatographic tests. Of the maternal and fetal blood, the latter contains 2 to 3 times as much ^{131}I (specific activity) during an incorporation period of 2 hours. In rabbits the maternal and fetal components of the placenta can be separated very well. In fetal placenta the specific activity of ^{131}I was higher in every case than in maternal and fetal blood, or in the maternal placenta. Of the fetal organs besides the thyroid glands, the epidermis, the liver, and particularly the stomach contained a great quantity of iodine isotope, especially in the early stage of pregnancy, this being verified by both measurements and autoradiograms. Thyronins are not produced in extrathyroideal organs according to chromatographic tests performed by isotope technique. (auth)

10781 RADIOACTIVITY IN THE MILK OF SUBJECTS RECEIVING RADIOACTIVE 19-NORSTEROIDS. Pincus, G.; Bialy, G.; Layne, D. S.; Paniagua, M.; Williams, K. I. H. (Worcester Foundation for Experimental Biology, Shrewsbury, Mass.). Nature, 212: 924-5(Nov. 26, 1966).

Lactating rabbits were given 6,7-^{3}H-ethynodiol diacetate, and lactating women were given 6,7-^{3}H-norethynodrel. Samples of milk were tested for radioactivity by liquid scintillation spectrometry. Results are tabulated. Very little of the radioactive dose was transferred to the milk. Samples of milk from each subject were injected into 21-day old female mice. The mice were killed 72 hours later and uterine weights were determined. There was no increase in uterine weights; this indicated that the estrogenic activity of the milk was too low to be detected. (H.L.W.)

10782 RADIOCALCIUM ABSORPTION AT DIFFERENT TIMES OF DAY. Samachson, Joseph; Scheck, Josephine; Spencer, Herta (Veterans Administration Hospital, Hines, Ill.). Amer. J. Clin. Nutr., 18: 449-51(June 1966).

In studies of the absorption of radiocalcium by man, the tracer is usually administered as part of a single meal and it is assumed that the absorption determined from this single dose will be typical of absorption throughout the day. However, the percentage of absorption depends on the conditions under which a radioisotope is administered; thus, the absorption by volunteer subjects of ^{87m}Sr given with a meal was less than that of ^{87m}Sr given during a fast. To investigate this problem ^{47}Ca (and ^{85}Sr) were given orally to the same patients in separate studies, both in the morning and in the evening, and percentages of absorption were compared. Intravenous doses of ^{47}Ca or ^{85}Sr, in solution as the chlorides, were administered at 0.2 to 0.7 $\mu C/kg$, of body weight, and plasma samples were drawn 1, 4, 8, and 24 hr after radioisotope administration. Two patients studied were on a low-calcium intake, two on a medium-calcium intake, and two on a high-calcium intake. The variability of absorption of radiocalcium from morning to evening doses with any level of calcium intake was about equal to the variability of repeated morning doses ingested on different days, and the absorption of radiocalcium was not consistently greater at either time of day. It therefore appeared that the ingestion of radiocalcium with a single meal reflected with reasonable accuracy the absorption of calcium during the day. (BBB)

10783 DIRECT AND INDIRECT EFFECTS OF RADIATION: THE RADIOLYSIS OF SUGAR. Steward, F. C.; Holsten, R. D.; Sugii, M. (Cornell Univ., Ithaca, N. Y.). Nature, 213: 178 (Jan. 14, 1967).

There is evidence that important biological effects can arise from the presence of stable radiolysis products of sugar in the culture media of plant cells or tissue explants. These effects neutralize the action of growth stimulatory substances which induce cell division and cause otherwise quiescent cells to grow rapidly. Growth in the presence of these radiolysis products may result in abnormal mitotic and meiotic chromosomes in materials such as root tips and pollen cells. Attempts have been made to isolate and identify the biologically active constituents in the many radiolysis products from sugar. A salt of formic acid was isolated and identified. How far formic acid contributes to cytotoxic and to cytological or genetic effects is not yet known. A yellow syrup was also isolated which inhibits growth in carrot cells; identification of this is incomplete. Tests made with irradiated glucose and fructose gave comparable biological results. (UK)

10784 ULTRACENTRIFUGAL STUDY OF BOVINE HEMOGLOBIN. Ou, Li-tse; Yang, Chi-chuen. Bull. Inst. Chem., Acad. Sinica, No. 12, 55-9(Sept. 1966).

The ultracentrifugal study of bovine hemoglobin was carried out using an air turbine type ultracentrifuge. The sedimentation coefficient of hemoglobin in dilute solution was independent of concentration and had an average value of 4.41S. The molecular weight of hemoglobin was calculated as 68,000 by the method of sedimentation-diffusion. The sedimentation coefficients of ^{60}Co γ-irradiated hemoglobin were slightly different from those of the unirradiated hemoglobin. The hemoglobin irradiated in solution state was more liable to decrease in sedimentation coefficient than that in dry state. (auth)

10785 ELECTRONIC AND KINETIC INVESTIGATIONS OF CHANGES IN THE ACTIVITY OF CATALASE IN RADIATION INJURY. Aleksandrov, Tsv.; Bonev, L.; Nikolov, Iv.; Krustanov, D. (Scientific Research Inst. of Radiology and Radiational Hygiene, Sofia). Rentgenol. Radiol., 3: No. 4, 42-6(1964). (In Bulgarian).

Fourteen widely known radioprotectors were tested. Reversible inhibition of catalase in vitro was found. It is concluded that the radioprotective and radiosensitizing mechanisms are greatly dependent on the state of catalase in the biological structure or on the systems functioning as catalase. (auth)

10786 ANOMALOUS EMISSION OF CHLOROPHYLL, STIMULATED BY RUBY LASER. Tererin, A.; Kobyshev, G.; Lialin, G. (Leningrad Univ.). Photochem. Photobiol., 5: 689-91(Aug. 1966).

Solutions of chlorophyll a, methylchlorophyllide a + b, chlorophylline, Mg-phthalocyanine in ethanol (10^{-3} mole/l), and metal-free phthalocyanine in dioxane (10^{-4} mole/l) were subjected to a ruby laser beam. The laser had a light energy of 1 J per pulse of 1 msec duration, their frequency being 2 per sec. The laser beam was filtered through a 5-mm thick red glass, eliminating wavelengths shorter than 660 nm. For chlorophyll a, methylchlorophyllide a + b, and chlorophylline, a distinct blue-green emission was observed in the narrow path of the laser beam. For the phthalocyanines this emission was absent. Evacuation of air from the solutions did not affect in any way the observed emission. On freezing the ethanol solution to 77°K the effect disappeared. The emitted spectrum recorded for methylchlorophyllide is shown. The spectrum consists of a band between 510 and 430 nm with a max at 480, i.e., at definitely shorter wave-length than that of the exciting light. The 480 nm band is situated near and on the red side of the Soret absorption band at 430 nm. Evidently the observed emission represents a radiative transition from the level of the Soret band to the ground state. To reach this singlet level the summation of the energies of two red photons is necessary. High triplet molecule concentration and a consequent triplet-triplet annihilation with energy summation up to the singlet level $^1\Gamma_2$ is suggested as the most likely explanation. (BBB)

10787 DEPOSITION AND FATE OF INHALED ^{59}Fe OXIDE IN RATS. Casarett, L. J.; Epstein, B. (Univ. of Rochester, N. Y. Weequahic High School, Newark, N. J.). Amer. Ind. Hyg. Ass. J., 27: 533-8(Nov.-Dec. 1966).

The fate of inhaled $^{59}Fe_2O_3$ in rats at short intervals of time after inhalation was studied primarily to evaluate the material for cytokinetic studies of the lung. Following nose only types of exposures, complete analyses were performed on tissues and excreta. Upper and lower respiratory tract retention is presented in two ways. The differences in clearance rates thus obtained are due to a significant early absorption or transport as reflected in carcass values. It is concluded that Fe_2O_3 is adequate for cell studies but emphasis is given to the need for characterization of the aerosol, particularly for solubility and ultrafilterability in other test uses. (auth)

10788 EFFECTS OF THE COUNTER ION AND pH ON INTESTINAL ABSORPTION OF CALCIUM AND STRONTIUM. Waldron-Edward, Deirdre; Paul, T. M.; Skoryna, Stanley C. (McGill Univ., Montreal). Proc. Soc. Exp. Biol. Med., 123: 532-8(Nov. 1966).

Ligated intestinal segments in rats were prepared without disturbing the vascular or lymphatic supply. The pH of the contents of the lumen, measured immediately after excision of the segment, ranged from 5.96 in the proximal jejunum to 7.24 in the terminal ileum. Introduction of an acid phosphate buffer reduced the pH of all segments to the range 5.95 to 6.19. Tris (hydroxymethyl) aminomethane increased the pH to the range 7.03 to 7.6. Acid phosphate decreased the absorption rate of ^{85}Sr whereas the alkaline Tris reagent increased absorption of both ^{85}Sr and ^{45}Ca from all segments, except from the duodenum, which appears to have a maximum limiting rate. Intubation experiments confirmed the results obtained with ligated segments: the total absorptive capacity of the small intestine for these ions is decreased by acid phosphate and increased by the alkaline Tris reagent. (auth)

10789 INACTIVATION OF BACTERIOPHAGES BY HYDROXYLAMINE AND BY UV IRRADIATION. Vizdalova, M.; Pillich, J. (Biophysical Inst., Brno). Cesk. Fysiol., 15: 420 (Sept. 1966). (In Czech).

The inactivation effect of hydroxylamine (HA) and of UV irradiation was studied on bacteriophages E. coli, T series. The mechanism by which HA affects the phages is different from the mechanism of UV irradiation. HA affects mainly the cytosineguanine pairs of DNA. Phages where cytosine is replaced by 5-hydroxymethylcytosine are more resistant to HA than other phages. The effect of the UV irradiation is due to the formation of thiamine dimers in the polynucleotide chains. (JPRS)

10790 EXCRETION OF ADMINISTERED p-AMINOBENZOIC ACID IN URINE OF IRRADIATED RATS. Fendrich, Z.; Grossmann, V. (Charles Univ., Hradec Kralove, Czechoslovakia). Cesk. Fysiol., 15: 414(Sept. 1966). (In Czech).

The amount of acetylation in p-aminobenzoic acid (PABA) after irradiation was investigated. The amount of PABA on the 3rd and the 6th day following irradiation is substantially reduced. The amount of the excreted acetylated form does not change substantially as a result of irradiation. It seems that irradiation does not affect the ability of rats to acetylate PABA, and the acetylated form is fully excreted in the urine. Only the amount of free PABA increases in the organism as a result of irradiation. (JPRS)

10791 MECHANISM OF THE CATION EFFECT IN SUBFRACTIONATION OF MICROSOMES. Dallner, Gustav; Nilsson, Robert (Univ. of Stockholm). J. Cell Biol., 31: 181-93(Oct. 1966).

It was previously found that cations introduced into a discontinuous sucrose gradient exert a very pronounced effect on microsomal vesicles, and this principle proved to be effective in microsomal subfractionation. The mechanism of the cation effect was investigated. By using the radioactive isotopes ^{137}Cs and ^{85}Sr, it could be calculated that the amount of ions bound to the various subfractions increases their density by 0.14%, thereby enhancing the sedimentation velocity by only ~7%. In the presence of Cs^+ the total volume of the microsomal pellet was decreased by ~15%. Assuming this change in volume to be due to a contraction of the individual vesicles, a roughly 2½-fold increase in sedimentation

velocity would be expected. It is further demonstrated, on the basis of light scattering and millipore filtration experiments, that monovalent cations cause an extensive aggregation of rough microsomes and a less pronounced aggregation of smooth microsomes. The mean radius of the sedimenting particles of rough microsomes was found to be at least doubled or trebled in the presence of Cs^+, which would give a 4- to 9-fold increase in the sedimentation velocity. Aggregation, therefore, appears to be the main factor in the accelerated sedimentation of rough microsomes in the presence of CsCl. Divalent cations exert a similar effect on a subfraction of the smooth microsomes. Isolated smooth microsomes are very unstable and often exhibit spontaneous aggregation. The presence of attached ribosomes, however, appears to impart greater stability to the rough microsomes as well as increasing their ability to bind monovalent cations. The primary cause of the aggregation of microsomal vesicles is probably due to a change in net charge. (auth)

10792 TURNOVER RATE AND DISTRIBUTION PATTERN OF RADIOSTRONTIUM IN THE SKELETON OF THE LAYING HENS. Ansari, M. N. A.; Creger, C. R.; Colvin, L. B.; Allen, W. S.; Couch, J. R. (Texas A and M Univ., College Station). Proc. Soc. Exp. Biol. Med., 123: 609-12(Nov. 1966).

Fourteen laying hens were administered 10 μC ^{89}Sr each (intramuscularly), and 2 birds were killed at 12 hours, 1, 2, 4, 8, 16, and 24 days, respectively. The soft tissues were cleared from the skeleton and all bones were analyzed for ^{89}Sr content by liquid scintillation. It was observed that all bony tissues participate in ^{89}Sr exchange, and that the ribs had the highest turnover rate, whereas, the skull had the lowest turnover rate. In general, it was found that bones composed primarily of spongy bone tissue turned over Sr faster than those of more compact construction. (auth)

10793 LIPOPROTEINS AND CHOLESTEROL IN BLOOD SERUM IN EXPERIMENTAL RADIATION DERMATITIS. Gosnovskii, A. T. (Belorussian Science-Research Inst., USSR). Zdravookhr. Kazakhstana, No. 11, 53-5(1964). (In Russian).

Experiments were conducted on the radioinduced changes in the content of lipoproteins and cholesterol in serum of 30 chinchilla rabbits of both sexes weighing 2200 to 3700 g. Unfiltered 60-kv x irradiation was applied to a section of the skin of 50 cm^2 area on the rabbits' back to total doses of 3000 R, at the dose rate of 55 R/min, to produce dermatitis. The rabbits were observed regularly and tests to determine the serum level of lipoproteins were made at various intervals, from 24 hr after irradiation to 164 to 200 days, when the affected areas had healed. An increase of β-lipoproteins was noted in 26 of the 30 animals, three of which showed an increase of β-lipoprotein to 90% of the total lipoprotein, while α-lipoproteins decreased and the β/α lipoprotein ratio remained fairly stable. The content of β-lipoproteins continued to increase 3 to 4 days after irradiation reaching an average of 70.8% of the total serum lipoprotein, α-lipoproteins decreased to 29.2, and the β/α ratio remained 3.4. Six days after irradiation the β-lipoprotein level was 70%, α-lipoproteins 30% and the ratio 2.74; thus from the 4th to 6th day the percentages remained fairly steady. Three to 4 weeks after irradiation moist desquamation and ulceration appeared on the skin, and the nidus became covered by a dense grayish scab. Having already approached the initial level by the 10th day after irradiation, by the time the skin had completely healed (164–200 days after irradiation), the average content of serum β-lipoproteins and α-lipoproteins was nearly normal. Thus, variations of the content of lipoproteins during radiation dermatitis in rabbits occurred only in the early phase of the reaction. (BBB)

10794 OBSERVATIONS ON THE BEHAVIOR OF GLYCOGEN IN THE VAGINAL AND VESICAL EPITHELIUM OF THE RAT AFTER WHOLE-BODY IRRADIATION WITH ^{60}Co. Ruggeri, F.; Sciascia (Univ., Bologna). Boll. Soc. Ital. Biol. Sper., 42: 133-4(Feb. 15, 1966). (In Italian).

Discordant results have previously been obtained on the effect of ionizing irradiation on the glycogen content of tissues. It is possible that different endocrine conditions existing in different experiments may account for these discrepancies. For the present study, glycogen content of the vagina and bladder epithelium of pregnant rats, under known endocrine influence, was examined after a single lethal dose of radiation. Sprague-Dawley rats in the 15th day of gestation were exposed to 1000 R from a ^{60}Co source of γ rays, at a dose rate of 71 R/min. Samples of vagina and bladder were immediately removed from rats sacrificed at two to 70 hr postirradiation, and frozen in solid CO_2. Sections were examined for glycogen by the periodic-acid-Schiff and Alcian blue methods. The results showed no detectable changes in the glycogen content of vaginal or vesical epithelium as compared with nonirradiated rats. However, sections of liver obtained 4 hr postirradiation showed decreased glycogen levels. It is concluded that glycogen in different tissues reacts differently to the effects of ionizing irradiation. (BBB)

10795 HYPOVITAMINOSIS B_6 AND BONE METABOLISM OF ^{85}Sr IN THE GROWING RAT. Bracci, R.; Benedetti, P. A.; Malandrini, F.; Cordelli, F. (Univ., Siena, Italy). Atti Accad. Fisiocrit. Siena, Sez. Med.-Fis., 12: 1259-62(1963). (In Italian).

The effect of vitamin B_6 deficiency on radiostrontium metabolism, particularly in bone, was studied in male Wistar rats weighing 90 to 110 g. The rats were maintained on a vitamin B_6-deficient diet for 10 days before intraperitoneal injection of 3 μC of ^{85}Sr. The max radioactivity in bone was reached 6 hr later in control rats but not until 24 hr later in vitamin B_6-deficient rats. Thereafter, the radioactivity declined more slowly in deficient rats. The percentage of radioactivity remaining, based on max radioactivity reached, was 84% and 64% in deficient and normal rats 2 days postinjection, 76 and 52% at 4 days, and 62 and 41% at 8 days. Bone ash and total-body (carcass) ash were compared for radioactivity at the end of 8 days. It was found that bone ash radioactivity as percentage of total radioactivity was 83% in the deficient and 81% in the control rats. It is evident that the higher uptake of radiostrontium by bone of growing vitamin B_6-deficient rats is accompanied by a retarded elimination of the radionuclide from bone. (BBB)

10796 DISTRIBUTION OF RADIOMANGANESE IN EMBRYONIC TISSUES OF THE MOUSE. Koshida, Yutaka; Kato, Mikita; Hara, Tomiyuki (Univ. of Kyoto). Annot. Zool. Jap., 38: 1-7 (Mar. 1965).

Studies were conducted on the distribution and excretion of radiomanganese, administered to the mouse, by autoradiographic observations on embryos. Photoelectric measurements were made of autoradiograms to determine exactly the radiomanganese concentration retained in embryonic tissues and organs, since this cannot be determined by ordinary radioassay techniques applied to isolated tissues. Manganese-52 was produced through the nuclear reaction $^{52}Cr(d,2n)^{52}Mn$ with the Osaka University cyclotron. Carrier-free $^{52}MnCl_2$ was prepared by the radiocolloid method and dissolved in 0.9% NaCl solution. About 10 μC of this solution was intravenously injected in female mice in different gestation periods. The mice were sacrificed 2 hr after injection. In the 18-day embryo, liver contains a relatively large amount of radiomanganese, probably owing to its active function of producing blood cells. The kidney at this embryonic stage shows a lower concentration of radiomanganese than the adult kidney carrying out urine formation. In the 12-day embryo, radiomanganese is concentrated abundantly in the brain where mitotic figures are frequently observed. In the 9-day embryo, it is incorporated slightly and homogeneously among the tissues. Thus radiomanganese seems to be accumulated predominantly in embryonic parts which are actively differentiating. (BBB)

10797 INFLUENCE OF GAMMA-RADIATION ON THE INCORPORATION OF ^{14}C-ADENINE AND ^{14}C-PHENYLALANINE INTO WHOLE AMOEBAE AND NUCLEATE AND ANUCLEATE AMOEBA FRAGMENTS. Skreb, Yvette; Horvat, Durda (Inst. for Medical Research, Zagreb). Exp. Cell Res., 43: 639-44(Oct. 1966).

Autoradiographic studies of the incorporation of ^{14}C-adenine and ^{14}C-phenylalanine into gamma irradiated whole amoebae and amoeba fragments showed that the synthesis of RNA and proteins in Amoeba proteus is not entirely under nuclear control. The nucleus, though irradiated, can partially repair the damage caused to RNA and protein synthesis by γ radiation. The quantity of cytoplasm present during irradiation plays a role in the protection of the nucleus and contributes to its repair. (auth)

10798 EFFECT OF CYTOSTATIC ALKYLATING AGENTS ON DEOXYRIBONUCLEO PROTEIN COMPLEX OF LYMPHATIC AND HAEMOPOIETIC TISSUE. Matyasova, J.; Skalka, M. (Inst. of Biophysics, Brno). Neoplasma, 13: 433-42(1966).

The effects of radiation and cytostatics on the release of deoxyribopolynucleotides from lymphatic and hematopoietic tissues is compared. After application of cytostatics in a dose corresponding to LD_{50} as after irradiation it arrives to an increase of the level of deoxyribopolynucleotides in the spleen and in the thymus of mice. From the drugs used Degranol was the most effective, Endoxan, TS 160, and Ypenyl were less effective. The maximal release of deoxyribopolynucleotides is delayed after the application of cytostatics, compared to irradiation. Whereas after the irradiation the maximum is in 4 to 8 hours, after the application of cytostatics it is in 8 to 10 hours. In a combined action of radiation and of cytostatic it arrives after smaller doses in the spleen and in the thymus of mice to a summation of effect of radiation and of Degranol; after larger doses the effect is not additive. For this reason it is probable that the used cytostatic influences the same cells as the radiation does. (auth)

10799 STRONTIUM INCORPORATION INTO DENTAL ENAMEL. Johnson, A. R.; Armstrong, W. D.; Singer, Leon (Univ. of Minnesota, Minneapolis). Science, 153: 1396-7(Sept. 16, 1966).

Rats were raised on diets either rich or poor in strontium. Powder x-ray diffraction patterns suggest that isomorphous substitution of strontium for calcium occurs in the apatite of tooth enamel, and that strontium may form $Sr_6H_3(PO_4) \cdot 2H_2O$, a compound hitherto unreported in biologic systems. (auth)

10800 DEPENDENCE OF THE OXYGEN EFFECT ON THE ENERGY OF FAST NEUTRONS. Barendsen, G. W.; Broerse, J. J. (TNO, Rijswijk, Netherlands). Nature, 212: 722-4 (Nov. 12, 1966).

The oxygen enhancement ratio (OER), or extent to which oxygen enhances radiation damage in biological systems, of fast neutrons was measured. The survival of cultured cells of human origin exposed in oxygenated and anoxic environments to monoenergetic fast neutrons of 3 MeV or 15 MeV or neutrons from the fission of ^{235}U with a maximum intensity of 1.5 MeV was determined. The OER values obtained from these data were 1.6 for 15 MeV neutrons and 1.5 for 1.5 MeV neutrons. Earlier experiments with the same cell system yielded OER values of 2.6 for 250 kVp x rays and 1.6 for fast neutrons. It was concluded that the OER is little dependent on neutron energy. Comparison of the data with results of previous studies led to the conclusion that OER values depend on the test system. The results also indicated that the OER of radiation with wide LET spectra is a complicated function of the LET distribution. The possible therapeutic effects of fast neutrons for the treatment of neoplasms with anoxic cells are discussed. (C.H.)

10801 CHANGES IN THE METABOLISM AND THE EFFECT OF PROCAINE AFTER IRRADIATION. Martinkova, J.; Grossmann, V.; Brunatova, M. (Charles Univ., Hradec Kralove, Czechoslovakia). Cesk. Fysiol., 15: 413(Sept. 1966). (In Czech).

The distribution of procaine between the blood corpuscles and the plasma after irradiation was investigated. Procaine is present more in the corpuscles than in the plasma following irradiation; on the 3rd day the difference disappears, and on the 6th there is more procaine in the plasma. Paraaminobenzoic acid disappears from the plasma to a great extent, and is concentrated in the corpuscles following irradiation. Drugs of a cationic nature have higher levels in the plasma after irradiation because their bonding increases; in drugs of an anionic nature the bonding in the plasma after irradiation decreases. (JPRS)

10802 UPTAKE OF ORGANIC AND INORGANIC RADIOACTIVE SUBSTANCES AND MULTIPLICATION OF MYCOBACTERIUM LEPRAE MURIUM ON ALKALINE GALACTOMANNAN MEDIUM. Ghys, R.; Gozsy, B.; Kato, L. (Univ., Montreal). Can. J. Microbiol., 12: 1137-43(Dec. 1966).

A limited multiplication of Mycobacterium leprae murium occurred in an alkaline galactomannan medium. Multiplication was enhanced by parabiosis with Torula minuta cells. Iron-59 uptake was proportional to the rate of multiplication and dependent on the pH and NaCl concentration as well as on the amount of Fe in the medium; however, ^{65}Zn uptake was independent of Zn concentration up to a concentration of 10 mg Zn/l. Glucose ($^{14}C_1$, $^{14}C_6$), asparagine, glycerol, and histamine were not adsorbed by the bacilli in significant amounts. The authors discuss the usefulness of measurements of ^{59}Fe uptake for studies of the nutrients that can be used by this noncultivable microorganism, and those that are essential for its multiplication. (auth)

10803 ACTIVATION OF RIBONUCLEASE I BY GAMMA IRRADIATION OF 30 S RIBOSOMES FROM ESCHERICHIA COLI. Kucan, Z. (Inst. Ruder Boskovic, Zagreb). Croat. Chem. Acta, 38: 97-104(1966).

A sensitive assay of ribonuclease activity was designed using polyuridylic acid as a substrate. The amount of the undigested polyuridylic acid was subsequently determined in a cell-free system for the polymerization of phenylalanine from Escherichia coli. This assay was used for the characterization of a nuclease activated by the irradiation of purified ribosomes from the same bacterium. The enzyme was identified as ribonuclease I by: its location on the 30 S ribosomal subunit; by the absence of mononucleotides in the products of short incubation, as determined by paper chromatography; and by identification of oligonucleotides as products of such an incubation using chromatography on dextran gel. Activated enzyme sedimented with 30 S ribosomes and exhibited its activity even at the concentrations of Mg^{++} which are inhibitory for the latent ribosomal ribonuclease. (auth)

10804 LOCALIZATION OF MERCURIC CHLORIDE ACCUMULATION IN RAT KIDNEY. Taugner, R.; zum Winkel, K.; Iravani, J. (Univ., Heidelberg). Arch. Pathol. Anat. Physiol., 340: 369-83(1966). (In German).

After injection of $^{203}HgCl_2$, its distribution in the rat kidney was studied by frozen section autoradiography and by counting the activity in the various segments of the kidney. High concentrations of ^{203}Hg were found either in the cortical regions; i.e., in the middle portion of the proximal convolution (distribution pattern 1), or in the outer strip of the outer zone of the medulla; i.e., in the terminal part of the proximal tubule (distribution pattern 2). Pattern 1 developed after injecting 0.1 to 0.5 mg Hg/kg and remained as such up to 48 hr; the same pattern occurred at the beginning with nephrotoxic doses of 1 to 10 mg Hg/kg, but then changed after 12 hr to distribution pattern 2. (BBB)

10805 RESEARCH ON BONE UPTAKE OF RADIOSTRONTIUM (^{85}Sr) IN ANIMALS MADE DIABETIC WITH ALLOXAN. Benedetti, P. A.; Bracci, R.; Cordelli, F.; Malandrini, F. (Univ., Siena, Italy). Atti Accad. Fisiocrit. Siena, Sez. Med.-Fis., 12: 1339-43 (1963). (In Italian).

Male Wistar rats weighing 150 to 180 g were made diabetic by a single 35-mg/kg dose of alloxan administered intravenously. Ten days later, when glycemia exceeded 200 mg% and glycosuria was 300 to 500 mg%, they were intraperitoneally injected with 5 μCi of ^{85}Sr. Alloxan diabetic rats were found to eliminate radiostrontium faster than normal rats. The respective retained radioactivities, as percentage of the max value reached, in the two groups were: at 2 days postinjection, 53, 66% of the amount injected; at 3 days, 41, 58%; and at 5 days 25, 50%. The bone retention as percentage of total retention of ^{85}Sr was slightly higher in the diabetic group (85%) than in the control rats (83%). The results resemble those found with ^{45}Ca, wherein intestinal absorption of the isotope was reduced in alloxan diabetes. Insulin treatment reversed this deficit. (BBB)

10806 EXPERIMENTAL PRODUCTION OF SARCOMA BY THE USE OF BERYLLIUM OXIDE. Yamaguchi, Shigeyoshi (Nagasaki Univ.). Acta Med. Nagasakiensia, 9: 49-63(Oct. 1964).

Osteogenic sarcoma was produced experimentally by the repeated injection of beryllium oxide (BeO) directly into the femoral bone marrow of rabbits. Young rabbits weighing 1.5 kg were injected with 1 ml of 1.0% suspension of BeO in physiologic saline. Ten rabbits were given a single injection of beryllium, and 43 were injected twice a week. Of 30 rabbits which survived for more than 9 months, 25 (84%) developed osteogenic sarcoma, chondrosarcoma, or presarcomatous changes. BeO was seen distributed throughout the bone marrow 5 hr after the initial injection but no tissue reaction was noticed. However, 10 hr after the injection an increase of granulocytic blast cells or young megakaryocytes was seen in addition to a leukocytic reaction. Focal proliferation of young mesenchymal cells which seemed to be derived from reticulocytic cells was seen. In animals examined 4 days after the injection, marked proliferation of spindle-shaped mesodermal cells, presenting a picture similar to that of sarcoma, was seen around the injected BeO. In one animal, abnormal proliferation of osteoblastic cells accompanied by frequent karyokinesis was noted and in another, marked proliferation of bony trabeculae was seen in addition. These findings were interpreted as a presarcomatous stage. (BBB)

10807 INFLUENCE OF HYPOVITAMINOSIS A ON BONE METABOLISM OF ^{85}Sr IN THE RAT DURING GROWTH. Bracci, R.; Cordelli, F.; Benedetti, P. A.; Malandrini, F. (Univ., Siena, Italy). Atti Accad. Fisiocrit. Siena, Sez. Med.-Fis., 12: 1247-51 (1963). (In Italian).

Since vitamin A deficiency is known to modify bone metabolism, its effect on the body distribution of a bone-seeking radionuclide was examined. Rats of the Wistar strain weighing 30 to 50 g were placed on a vitamin A-deficient diet for 40 days and then injected intraperitoneally with 3 μCi of ^{85}Sr. In deficient animals max activity was reached more slowly than in controls (24 to 48 hr postinjection vs 6 hr). The retained radioactivity, as percentage of max activity, was 87 and 66% in deficient animals and controls at 2 days, 78 and 55% at 4 days, and 54 and 44% at 8 days. The proportion of the radiostrontium in bone ash to total body ash was 65% in vitamin A-deficient rats and 81% in control rats. It is evident that hypovitaminosis A rats is accompanied by a delay in removal of radiostrontium from bone. (BBB)

10808 REDUCTION OF CYSTINE AND PEPTIDE-BOUND DISULFIDES BY HYPOPHOSPHITE AND ULTRAVIOLET LIGHT. Swanepoel, O. A. (South African Wool Textile Research Inst., Grahamstown). J. S. Afr. Chem. Inst., 16: 48-50(1963).

Disulfide bonds in cystine, oxidized glutathione, and keratin were reduced to sulfhydryl groups by hypophosphite ions at elevated temperatures and at temperatures as low as 10°C when the reaction mixtures were exposed to uv irradiation. Cystine, glutathione, ox insulin, lysozyme, and bovine plasma albumin were the compounds used in tests. Content of disulfide bonds remaining in final solutions was determined by amperometric titration with methyl mercuric iodide. The procedure adopted for the reduction of the disulfide bonds and the method for estimation of the level

of reduction that occurred are outlined. Ultraviolet radiation for one hr of a solution of cystine in 0.1 M HCl produced a negligible change in content of disulfide bonds; however, a near quantitative conversion of cystine into cysteine took place when the same solution was irradiated for one hr in the presence of hypophosphite ions. Ultraviolet irradiation of compounds with single disulfide linkages mixed with sodium hypophosphite solution resulted in rapid decomposition of the compounds to their corresponding thiols. The high degree of SS reduction occurred during relatively short irradiation periods; therefore, additional effects from uv irradiation of the treated compound, as well as the resulting thiol, were regarded as negligible. The disulfide linkages in the proteins tested were more rapidly reduced to sulhydryl groups when hypophosphite was present in uv irradiated solutions. A significant degree of reduction in disulfide linkage in the protein compounds tested was obtained when they were exposed to uv irradiation for relatively short periods of time in the presence of hypophosphite. In the reaction between hypophosphite and disulfide-containing compounds at elevated temperatures, the reaction followed a stoichiometry of two cysteine groups formed per reacted disulfide linkage. (TSS)

10809 EFFECT OF ULTRAVIOLET RADIATION ON STEROL METABOLISM IN THE RAT. Horlick, L. (Univ. of Saskatoon, Saskatchewan). J. Atheroscler. Res., 6: 173-83(Mar.-Apr. 1966).

It has been reported that uv irradiation of rabbits fed cholesterol resulted in a striking inhibition of experimental arteriosclerosis and prevented the expected rise in the serum cholesterol level. The problem was reinvestigated in male rats fed 1% cholesterol in the diet and that weighed 200-250 g. The rats were exposed to uv light from a distance of 40 cm for 1 hr/day for eight to 16 days. Other experimental animals were exposed to uv light from a distance of 25 in with a 15 min/day exposure for eight days and 10 min/day exposure for 12 days. Such uv irradiation resulted in cellular hyperplasia, local injury, and a significant increase in the nonsaponifiable fraction of the irradiated skin. A proportional increase in all of the sterols measured and a decrease in the fatty acids of the irradiated skin were observed. In vitro synthesis of sterols and fatty acids from acetate in the skin was found to increase following irradiation. No increase in sterol level in the liver or aorta was observed. Also, no increase in acetate or mevalonate precursor incorporation into sterols in the organs of irradiated animals was noted. Serum cholesterol and triglyceride levels were found to decrease in irradiated animals. Irradiation was thought to act as a stress agent in the production of adrenal hypertrophy. Cholesterol feeding alone had no significant effect on the weight of the adrenal gland. The results of this study indicated that the cholesterol-lowering effect of uv irradiation may relate to the stressful effect of irradiation via the pituitary-adrenal axis. (BBB)

10810 IMMEDIATE TOXICITY OF BERYLLIUM SALTS. Caujolle, F.; Pham-Huu-Chanh; Auvergne, E.; Mamy-Silve, G.; Luong-Thi-Ngoc-Suong; Patte, J. Arch. Mal. Prof. Med. Trav. Securite Soc., 26: 513(Sept. 1965). (In French).

Although many reports have been published on berylliosis and chronic poisoning by inhalation of Be dust or by ingestion of Be compounds, few reports have appeared on acute experimental poisoning with soluble Be salts. Moreover, the results with soluble salts are conflicting in some instances. The present study was designed to investigate subacute toxicity from intravenous infusion in dogs, cats, and rats, and the reaction to low or large doses in rats and mice by intravenous, intraperitoneal, or oral route. The latter experiments revealed the LD_{50}, which is attained after a delay of 5 to 6 days. The acute toxicity of beryllium was found to be comparable to that of zinc and cadmium. The location of beryllium in various organs was determined. (BBB)

10811 STUDIES ON PROSTATIC SECRETION. I. EXCRETION OF RADIOACTIVE IODINE IN PROSTATIC FLUIDS. Tanaka, Hiromi (Hiroshima Univ.). Hinyokika Kiyo, 11: 305-8(Apr. 1965). (In Japanese).

In adult male dogs the reappearance of intravenously injected ^{131}I into serum, urine, and prostatic secretion was followed. In prostatic secretions of the adult dog, about the same concentrations of ^{131}I as that in serum could be demonstrated. Its concentration in prostatic secretion fluctuates in proportion to that in serum. The ^{131}I is not actively concentrated in the prostatic gland over serum, but merely passes into the gland passively. The maximum concentration of ^{131}I after intravenous injection is achieved at 5 min in urine and at 15 min in prostatic secretion. The concentration of ^{131}I in prostatic excretions is inversely proportional to the amount of fluid excreted. (BBB)

10812 THE REDISTRIBUTION OF RADIOACTIVITY IN GEOTROPICALLY STIMULATED HYPOCOTYLS OF HELIANTHUS ANNUUS PRETREATED WITH RADIOACTIVE CALCIUM. Arslan-Cerim, Nimet (Univ. of Ankara). J. Exp. Bot., 17: 236-40(May 1966).

Movement of ^{45}Ca in sunflower seedlings was studied. Six-day old seedlings treated with 1 μC of $^{45}CaCl_2$ were placed horizontally for 1, 2, or 3 hr. The ^{45}Ca accumulated more in the upper half of the hypocotyl than in the lower half, particularly after 3 hr. Geotropic stimulation under nitrogen caused no significant difference between the two halves. The role of this differential accumulation of ^{45}Ca in geotropic curvature is discussed. (TSS)

10813 UPTAKE AND EXCRETION OF ^{137}Cs, POTASSIUM AND ZIRCON/^{95}Nb IN CATTLE. Hausken, O. Wegener; Nygard, J. J. (Norwegian Defence Research Establishment, Kjeller). Acta Vet. Scand., 5: 331-46(1964).

Data are given for the measurements of ^{137}Cs in agricultural products. These measurements demonstrated that there was a significant amount of ^{137}Cs in agricultural products in Norway. Spectrographic measurements were made to study the uptake and excretion of ^{137}Cs, K, and $^{95}Zr/Nb$ in cattle. The ratio between ^{137}Cs intake and the amount which passed into the milk was also determined. Different kinds of fodder were examined to determine which kind contributed most to the total intake of ^{137}Cs. (TSS)

10814 CHROMATOGRAPHIC SEPARATION OF IODINATED COMPOUNDS OF THYROID METABOLISM IN THE CRESTED NEWT (TRITURUS CRISTATUS CARNIFEX LAUR) AFTER LABELING WITH THE RADIOISOTOPE ^{131}I. Peyrot, Alberto; Pennisi, Francesco; Vaccarino, Carla; Biciotti, Mario (Univ., Turin). Gen. Comp. Endocrinol., 6: 125-9(Apr. 1966). (In French).

Crested newt were injected with ^{131}I and qualitative analyses of radioactive compounds from thyroid gland metabolism were determined by paper chromatography and thin layer chromatography. Labeled thyronines and tyrosines were detected by autoradiography. An elution system of collidine-3 N NH_4OH plus NH_3 vapor effectively separated monoiodotyrosine (MIT), diiodotyrosine (DIT), triiodothyronine (T3), and thyroxine (T4) on thin layer chromatograms. The presence of labeled T4 and T3, which appeared to occur in larger amounts in males than in females, in the thyroid hydrolyzates at 24 hr and 4 days, respectively, were noted. Whereas T4 appeared to labeled in triton within 24 hr after injection of the ^{131}I, in other urodeles it was formed much more slowly; in some urodeles the presence of T4 was not fully established. (BBB)

10815 EFFECT OF WHOLE BODY ^{60}Co GAMMA RADIATION ON INTESTINAL SUGAR ABSORPTION IN THE WHITE RAT. Chang, Li-fan; Chin, Chao-chi; Chin; Chia-pu; Wang, Fu-chou. Sheng Li Hsueh Pao, 29: 186-94(June 1966). (In Chinese).

This study observes changes in intestinal sugar absorption in anesthetized white rats following whole body ^{60}Co gamma radiation dose of 1294 roentgens. Selective absorption of glucose 24 hours later showed little change from that in control group; 48 hours later a marked drop, and 72 hours later an even lower drop, with practically a complete loss of selective absorption of glucose at the nonselective level. Intestinal absorption of xylose 48 and 72 hours after radiation also showed a slight drop. Though upper and lower sections of small intestines both show sensitivity to radiation, this effect was more marked in the upper segment. In vitro observations of intestinal mucous membrane after radiation showed retention of glucose absorption selectivity 24 and 48 hours later. However, this active motility and selective absorption of intestinal membrane to glucose were lost after 72 hours, and xylose permeability also dropped, though the radioactive iodine permeability was higher than normal. (JPRS)

10816 UPTAKE AND DISTRIBUTION OF ^{134}Cs APPLIED TO LEAVES OF BEAN PLANTS. Levi, E. (EURATOM-ITAL, Wageningen, Netherlands). Radiat. Bot., 6: 567-74(Dec. 1966).

The foliar uptake and subsequent transport of ^{134}Cs in bean plants was studied under controlled environmental conditions. The amount taken up by the plant was determined after washing the treated area. Uptake measurements were made for periods of up to 96 hr. The fraction not retained on the leaf surface decreased steeply at first, remaining relatively constant thereafter. The distribution of the ^{134}Cs in the plant indicated that the treated leaf contained a very large and nearly constant percentage of the activity taken up even after prolonged periods of growth. The other leaves or the fruit accumulated a very minor fraction, while the stem and roots as a whole had an intermediate activity. The possibility of cuticle fixation or cell accumulation is discussed. (auth)

10817 ISOLATION OF AUXOTROPHIC BACTERIA. Liska, Bohumir. Rozpravy Cesk. Akad. Ved, Rada Mat. Prirodn. Ved, 74: No. 4, 1-64(1964). (In Czech).

Isolation of auxotrophic strains of Escherichia coli after expo-

sure of E. coli 4/49 to uv radiation is reported. A survey of literature on methods for isolation of auxotrophic strains of bacteria and fungi, methods of induction, and means for increasing the occurrence of auxotrophic strains in bacterial cultures is given. Isolations of auxotrophic strains were made by: (1) the method of successive isolation of individual colonies, (2) replica plating method, (3) nutrient medium stab selection method, (4) delayed enrichment method, (5) marginal enrichment method, and (6) the penicillin method. The isolation methods were first tested with a 24-hr culture of E. coli 4/49 mixed with a 24 hr culture of auxotrophic E. coli M 200 (vitamin B_{12}). Individual methods were evaluated by irradiating a suspension of E. coli 4/49 with uv radiation. Auxotrophic strains of E. coli were obtained which required amino acids, vitamins, purine and pyrimidine bases of nucleic acids, or undefined substances contained in an enzymatic hydrolysate of casein. Methods and procedures for determination of the substances required by auxotrophic strains were also described. (BBB)

10818 LOW RADIOIODINE UPTAKE AND HIGH SERUM PBI LEVELS FROM HEMORRHAGE INTO THYROID ADENOMA. Greenberg, Harry B. (Touro Infirmary, New Orleans). J. Nucl. Med., 7: 787-91(Oct. 1966).

After hemorrhagic degeneration of a large follicular adenoma of the thyroid, a patient's serum PBI level was more than twice the normal value. The 24-hour radioiodine uptake was less than 5% of the administered dose of 100 μCi of iodine-131. High-contrast photoscanning over the thyroid confirmed the low ^{131}I uptake, and showed almost no ^{131}I in the region of the adenoma. The high serum PBI levels were attributed to the passage of preformed hormone and hormonally active iodinated amino acids from injured follicles into the circulation. The low ^{131}I uptake was attributed to depressed secretion of thyroid stimulating hormone. (auth)

10819 EFFECT OF X-IRRADIATION ON THE PHYSICO-CHEMICAL PROPERTIES OF DEOXYRIBONUCLEIC ACID. Harrington, Helen (Western Reserve Univ., Cleveland). Arch. Biochem. Biophys., 117: 615-22(Dec. 1966). (COO-78-131).

Intact lymphoblasts and isolated DNA were irradiated under conditions known to reduce the priming activity of DNA for Escherichia coli DNA-polymerase in order to detect structural alterations responsible for the decrease in biological activity. Irradiation of intact lymphoblasts with 1000 R caused single-strand breaks in the DNA as evidenced by a greater reduction in the viscosity of the DNA subsequently extracted and heat-denatured as compared with that observed in DNA extracted from control cells and denatured. Irradiation of DNA in dilute solution with 1000 R was more effective in producing alterations in the DNA, as evidenced by a reduction in the viscosity of native DNA, a reduction in the midpoint temperature of the thermal transition and sedimentation rate, and an increased sensitivity to alkaline phosphatase and a nuclease preparation from E. coli. It was proposed that enough single breaks are produced on opposite strands by the in vitro radiation to cause horizontal cleavage. Iodouracil substitution in the DNA increased the irradiation effect when intact cells were irradiated but not when the DNA was irradiated in dilute solution. (auth)

10820 MITOCHONDRIAL RESISTANCE TO MASSIVE IRRADIATION IN VIVO. IV. SUPPRESSION AND RECOVERY IN RATE OF AMINO ACID INCORPORATION INTO MITOCHONDRIAL PROTEIN. Romani, R. J.; Fisher, L. K. Arch. Biochem. Biophys., 117: 645-9(Dec. 1966). (UCD-34P112-26).

In vivo synthesis of mitochondrial protein was measured as a function of radiation dose and postirradiation time. A dose of 250 Krad will suppress incorporation of leucine-^{14}C into mitochondrial protein by about 50%. In 24 hours the rate of incorporation is nearly recovered. A 1000 Krad dose, however, results in a much greater and permanent inhibition. The observations, in concert with other responses of fruit mitochondria to massive irradiation, suggest a capacity in mitochondria for repair of reconstitution of massive radiation damage. (auth)

10821 EFFECTS OF X IRRADIATION ON ENZYMES IN TUMOR CELLS OF THE MTK SARCOMA III. Mumoto, Hajime (Tokushima Univ., Japan). Shikoku Igaku Zasshi, 16: 45-54 (Feb. 1960). (In Japanese).

The effects of 180-kv x rays on the activity of succinate dehydrogenase and alkaline phosphatase in tumor cells (MTK sarcoma III) were studied cytochemically in Wistar rats. The x-ray doses used were 200, 1000, and 5000 R. It has been established that the activity of succinic dehydrogenase and alkaline phosphatase in tumor cells is localized in the small granules and grains in the cytoplasm. After in vivo the irradiation activity of the two enzymes decreased slightly. The numbers of the granules and grains visualized by enzyme staining increased soon after irradiation. The changes induced by irradiation disappeared 3 to 6 hr after irradiation and enzyme activities returned to normal. The implications of these changes on the biochemical response to ionizing radiation are discussed. (BBB)

Ecology

Refer also to abstracts 10609, 10749, 11121, and 11136.

10822 (COO-1333-3) INVESTIGATIONS INTO THE CYCLING AND RECYCLING OF CERTAIN RADIONUCLIDES THROUGH THE MILK FOOD CHAIN. Annual Report No. 3, December 15, 1965–December 14, 1966. Whipple, G. Hoyt; Pelletier, Charles A.; Wedlick, Harold L. (Michigan Univ., Ann Arbor. Dept. of Environmental Health). Sept. 1966. Contract AT(11-1)-1333. 76p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The results of the third year of a research program on the behavior of fallout radionuclides in the milk food chain are presented. Mathematical expressions are derived and compared with the observed behavior of cerium-144, cesium-137, and potassium-40 on a commercial dairy farm. Preliminary comparisons substantiate the forms of the mathematical expressions. The results of balance studies for the above three radionuclides as well as calcium and strontium are presented. The results tend to confirm the experimental methods used. On the basis of the data analyzed so far it appears that mathematical expressions can trace with reasonable accuracy the behavior of a radionuclide from air to milk. (auth)

10823 (ORO-2789-17) CONCENTRATION OF SUSPENDED RADIOACTIVE WASTES INTO BOTTOM DEPOSITS. Progress Report, September 1, 1965–August 31, 1966. Haven, Dexter S. (Virginia Inst. of Marine Science, Gloucester Point). Sept. 1966. Contract AT(40-1)-2789. 128p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress is reported on preliminary studies on the concentration of suspended radioactive wastes in bottom deposits of estuaries. Data are reported from a study on the degree of variability that exists among benthic invertebrates in their ability to mix biodeposits into subsurface sediments. Samples of animals and sediments were collected monthly in the York River, Yorktown, Va. All faunal samples were sieved through 1.0, 0.5, and 0.25 mm screens and preserved for later identification. Data are tabulated on the total number, species, depth obtained, and screen size of animals collected from Aug. 1965 through Feb. 1966. Curves were drawn showing seasonal abundance and animal populations collected at 12.2 m were analyzed to identify species that constantly occurred together. Sediment samples were sieved and analyzed for silt and clay fractions. A computer program was developed to analyze sediment data for grain size, per cent sand, silt, clay, and silt-clay ratios. A preliminary analysis of the data shows that animal populations differ with depth and are associated with completely different sediment types. Differences in the feeding behavior of the animals at various depths would result in variation in the degree of removal of solids from suspension and in the subsequent mixing of the biodeposits into subsurface sediments. Results of an analysis of fecal pellets in suspension in estuarine waters of the James River, Va., indicated that biodeposits, and possible associated radionuclides, may be transported from one area to another in the form of large fecal pellets, that the production of fecal pellets from filter feeders may occur in one section of the river while accumulation occurs in a different section, and that the time required for pellets to break up may determine the speed of transport. Work continued on the determination of the size of particles that oysters remove from suspensions. Particle counts and size measurements were made with a Coulter Counter. The use of ^{85}Kr-kryptonated sand and kaolinite was found to be a satisfactory method to follow sediment mixing by various species of benthic animals. Results of aquarium studies are reported. (C.H.)

10824 OSSEOUS DEPOSITION OF RADIOACTIVE STRONTIUM IN CATTLE OF VARIOUS AGES. Lanzola, E.; Spina, A. M.; Alasia, A. M. (Univ., Rome). Nuovi Ann. Ig. Microbiol., 15: 552-60(Nov.-Dec. 1964). (In Italian).

In the spring of 1962, about 6 months after a series of Soviet thermonuclear tests, resulting in increased fallout levels, ^{89}Sr and ^{90}Sr were determined in the bones of cattle of various ages. For results obtained on March 5, 1962, the following mean values (as pC/g Ca) of ^{89}Sr and ^{90}Sr were obtained for cattle of ages indicated: 5 months 4, 10; 8 months 4, 11.5; 20 months --, 10; 4 yr --, 26; and 10 yr --, 6. The corresponding values obtained on May 11, 1962, were as follows: 4, 12.5; 10.5, 15.5; --, 9; --, 26; and --, 6. The $^{89}Sr/^{90}Sr$ ratios for the March and May assays were 0.40 and 0.32, respectively, for 5-month-old cattle and 0.35 and 0.68 for

8-month-old cattle. The reversal of this ratio demonstrates the rapidity with which radiostrontium enters the bone when the cattle are placed in pasture. The results also show that 4-yr-old cattle had accumulated the highest osseous levels of radiostrontium. This is attributed to the high levels of radiostrontium from fallout in the period 1958-1959 when the cattle were maturing. Ten-yr-old cattle had the lowest ^{90}Sr levels in bone. (BBB)

10825 ACCUMULATION OF STRONTIUM IN BOVINE BONES. Bohman, V. R. (Univ. of Nevada, Reno); Blincoe, Clifton; Wade, M. A.; Lesperance, A. L.; Fountain, E. L. J. Agr. Food Chem., 14: 413-15(July-Aug. 1966).

Stable Sr and ^{90}Sr in the bones of range cattle grazing on different range areas in Nevada were measured to determine the relation between the stable and radioactive elements under the conditions present. From 1958 to 1962, Hereford cattle from three locations in Nevada were slaughtered twice each year: the Nevada Test Site (NTS) and Delamar Valley (DV), located 50 mi east of the NTS herd in southern Nevada, and the Knoll Creek Field Lab (KC) of the Univ. of Nevada, located 70 mi south of Twin Falls, Idaho, and 300 mi north of the DV herd. Strontium-90 content of bovine bone ash followed a similar pattern irrespective of herd location. From levels of 4 to 6 pC/g bone ash initially, the content of ^{90}Sr increased about 10-fold during the 1958 and 1959 periods. During the early part of the study (1958-59), the ^{90}Sr content of bovine bone ash was higher for the KC herd; during the terminal years (1961-62), especially during the last year, the NTS herd was much higher. After the termination of the testing moratorium in September 1961, the uptake of ^{90}Sr by cattle on the NTS was appreciably greater and reflected the very rapid acceleration of testing in this area. Since the levels were similar between the KC and DV areas, most of the fallout was contained on the NTS or else bypassed the DV area as it traveled east. Accumulation of ^{90}Sr in the tissues of grazing beef cattle was also influenced by age of the animal; when the levels were elevated, younger animals had higher levels than mature cattle. Total strontium was characteristic of the location of the herd. When a herd was moved from an area of high concentration to a correspondingly low area, total strontium in bone ash gradually became similar to that in the new environment. Strontium-90 content of bovine bone ash was unrelated to either total strontium or calcium. Calcium level was related to total strontium, but the correlation was not high ($r = 0.5$). (BBB)

10826 IONIZATION OF THE AIR. (A REVIEW). Griffin, James E.; Kornblueh, Igho H. (Univ. of Pennsylvania, Philadelphia). Int. J. Biometeorol., 6: No. 1, 29-32(1962).

An investigative survey showed that the causes and effects of air ionization in both natural and artificial atmospheres have markedly increased in the last decade. It is now known that ions of very small dimensions (<0.03 μ) and relatively high mobility (>0.01 cm/sec/volt/cm) reach the alveoli of the lungs without having been neutralized. The review considered the 5 presently known means of artificial ion production and the most suitable method for use under certain experimental circumstances. Charge separation, thermionic emission, corona discharge, radioactive materials, and uv radiation were the sources considered. At present, corona discharge and tritium are the most widely used sources. It has been generally agreed for some time that for practical purposes the useful output of small ions from an artificial source is rather limited in relation to the total output. That small ion levels can produce demonstrable biological results in in vitro, in vivo, and in situ animal experimentation has been established. Daily exposures for 15 min to high negative ion concentrations was said to improve athletic performance. Partially because of the problems in achieving a high small ion density, there has been much work done on the physics of charged aerosols, that give rise to several hundred thousand charged condensation nuclei per cm^3 of air. Decay of either the small ions or a charged aerosol was found to be very rapid, on the order of 50% decay within 28 sec where the concentration is about 10^4 ions/cm^3. Small ions have been shown to decay more rapidly in the presence of an aerosol. Polonium-210 has been used as an ion source for studies on biologic effects of artificial air ionization. In hamsters, negatively ionized air increased the CO_2-combining power of plasma and shifted the pH toward the alkaline side. Hamsters raised in a negative ion environment attained full weight faster than litter mates raised in normal or positive ion environments. The healing rate of skin laceration was improved in negative ion environments as compared with controls. Observations of cell cultures, using tritium generators as an ion source, revealed that proliferation was greatly enhanced by negatively ionized environments in comparison to normal environments. Positive ionization was observed to depress the multiplication rate of the cells significantly. Negatively ionized cells were seen to continue proliferation at an increased rate after ionization ceased, whereas positively ionized cells recovered slowly from their depression. (BBB)

10827 EFFECT OF EXTRACTED SEAWEEDS ON THE MIGRATION OF ^{90}Sr AND ^{137}Cs FROM OCEANS AND SEAS TO THE FIRM LAND. Mironov, O. G. (Inst. of Biology of Southern Seas, USSR). Rybn. Khozy., No. 11, 17(1965). (In Russian).

The possible spread of strontium-90 and cesium-137 contained in extracted seaweeds is reviewed on the basis of published Soviet and foreign sources. A statistical table was presented giving the contents of ^{90}Sr and ^{137}Cs in edible and other seaweeds harvested from seas during the period from 1956 to 1960. The total five-year amount of ^{90}Sr in edible seaweeds was 19.81 millicuries and of ^{137}Cs was 47.76 millicuries. These extracted amounts are extremely low in comparison with the amounts absorbed by the sea water. However, the accumulation of radioactive isotopes per unit weight in the extracted seaweeds was many times greater than in fish taken from the water. It approached the accumulations of strontium and cesium in molluscs and crustaceans. Therefore, the effect of seaweeds on the spread of radioactive substances cannot be neglected. (auth)

10828 INSTITUTE OF ENVIRONMENTAL SCIENCES 1966 ANNUAL TECHNICAL MEETING, PROCEEDINGS, SAN DIEGO, CALIFORNIA, APRIL 13–15, 1966. Mt. Prospect, Ill., Institute of Environmental Sciences, 1966. 664p. $14.00. (CONF-660435).

Separate abstracts were prepared on three papers. One paper was abstracted previously and appeared in NSA Vol. 20 as number 46977. Other papers discuss various aspects of terrestrial and space environments. (C.H.)

For abstracts of individual papers see: 10717, 10718, and 10969.

Genetics and Cytogenetics

Refer also to abstracts 11127, 11129, and 11130.

10829 (ORO–3092-13) GENETICS INVESTIGATIONS OF INDUCED MUTATION AT THE Vb LOCUS IN OATS AND AT THE ddt LOCUS IN BARLEY. Annual Progress Report. Wallace, A. T. (Florida Univ., Gainesville). Dec. 1966. Contract AT(40-1)-3092. 34p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress is reported on investigations of induced mutations at the Vb locus in oats and at the ddt locus in barley, conducted for the purpose of obtaining information on the nature of induced changes at specific loci in higher plants. The Vb locus (or closely related multiple loci) controls the reaction(s) in oats, Avena byzantina C. Koch, to two pathogens. Each mutant was crossed to the susceptible parent and the F_2 ratios determined. Results indicated that most crosses give a 3:1 ratio. It was concluded that all of the mutants involved only one locus and that each allele is recessive to the wild type allele. Data from the F_2 root measurement distributions suggest that allelic complementation is being expressed and that it can be detected. The degree of resistance for each of 40 leaky mutants was determined by testing them in a series of toxin concentrations with the root bioassay test. Each of the leaky mutants was tested for loss of electrolytes, and it was found that most of the elements are leached from the cells of the treated tissue. Implications that the different responses to toxin can be separated by mutation are discussed. A method is described for desalination of toxin filtrates. Monosomic lines were selected and crossed with the susceptible parent. A very few lines of barley are resistant to DDT, a resistance controlled by a single pair of recessive genes. Studies of DDT-resistance showed that DDT in some way inhibits the synthesis of chlorophyll, a process that is enhanced by increase in temperature. Use of DDT-resistant males in allelic complementation studies is discussed. (H.G.D.)

10830 (TID–23414) RESEARCH IN GENETICS TO INCLUDE: (1) THE DIRECT AND INDIRECT EFFECTS OF RADIATIONS AND THEIR MODIFICATION ON GENETIC SYSTEMS, AND (2) POPULATION AND EVOLUTIONARY STUDIES OF DROSOPHILA. Final Report, January 1, 1962–December 31, 1965. (Texas Univ., Austin). Contract AT(40-1)-2952. 18p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Oxygen during irradiation increases the net radiation damage above that found if radiation is carried out in an inert gas such as argon. The data do not support a role of oxygen in healing genetic damage during intervals between radiation in Drosophila melanogaster, except perhaps in special conditions. Irradiation of 1000R in nitric oxide does not increase or reduce genetic damage measured as translocations from that found when irradiating in argon. It may produce more dominant lethals and/or, more probably, interfere in the production of normal sperm in a non-genetic fashion. Irradiation of 3000R in carbon monoxide in the dark is similar to irradiating in argon. The CO can be replaced with He, O_2,

NO or CO + NO during the interval between the two 1500 radiations without changing the effect. Some comparisons of the rates of translocations and recessive lethals were made. The first was the ratios of translocations to recessive lethals in the same experiment. The relative frequency (translocations/recessive lethals) is higher in the more susceptible spermatid stages. It is, also, higher in experiments where more radiation damage was produced by a higher dose of radiation or the presence of O_2. The ratios between recessive lethals recovered from similar experiments at doses of 3000R and 1000R, also, show the influence of cell sensitivity and environmental variables. The ratios between experiments 8E/4E, 10E/6E, 1H/1E, 1H/2E, 2H/1E and 2H/2E are similar within stages but differ between stages with a higher ratio accompanying higher damage. Spermatids have a higher ratio than sperm. Translocations give similar results, but the results are more variable. It is difficult to evaluate premeiotic stages which are exceptionally low. The fact that these are multiplying cells makes analysis difficult. The results suggest selection against cells with recessive lethals or against cells injured enough by radiation to have recessive lethals. (TSS)

10831 NON-INTERACTION OF RADIATION-INDUCED CHROMOSOME LESIONS IN TRADESCANTIA MICROSPORES. I. FRACTIONATED X-RAY DOSE STUDIES. Savage, John R. K. (Medical Research Council, Harwell, Eng.). Int. J. Radiat. Biol., 11: 287-300(1966).

After a priming dose of 300 rads, a response curve for chromosome exchanges has been obtained at the time of minimal dose interaction. Compared with a single-exposure dose–response curve induced at the same time, the fractionated curve is displaced downwards, since there is no interaction at any dose combination. It also shows pronounced saturation at higher total doses, suggesting a reduction in the number of effective exchange sites available to the second dose. Further evidence for such a reduction comes from the observation that the observed yields are consistently below those expected on the basis of simple additivity of the yields from the two dose fractions. Assuming that the original population had a limited number of effective exchange sites, the loss of interaction is shown to be consistent with the repair of partially damaged sites, but the data do not exclude the possibility that dose-dependent site inactivation is also a contributing factor. (auth)

10832 CHROMOSOME ABERRATIONS AND THE THEORY OF RBE. II. EVIDENCE FROM TRACK-SEGMENT EXPERIMENTS WITH PROTONS AND ALPHA PARTICLES. Neary, G. J.; Savage, J. R. K. (Medical Research Council, Harwell, Eng.). Int. J. Radiat. Biol., 11: 209-23(1966).

The LET-dependence of chromatid-aberration production in pollen tubes of Tradescantia bracteata and the influence of oxygen on the process have been determined by track-segment experiments with protons and alpha particles in the LET_∞ range up to about 100 kev/μ. The results are in good agreement with the concept that an aberration results from the interaction of two chromatid primary lesions and that a primary lesion is produced by a single energy-loss event in the DNA of a chromatid, probably affecting initially only one strand of the DNA. The data for breaks and gaps are explained most easily in terms of the exchange hypothesis of aberration formation. (auth)

10833 CHROMOSOME ABERRATIONS AND THEIR SIGNIFICANCE IN MODERN MEDICINE. Samuels, L. D. (Harvard School of Public Health, Boston). Med. Times, 93: 1049-57 (Oct. 1965).

Medical aspects of genetic injury resulting from chromosome aberrations caused by ionizing radiation are reviewed. The work of the various disciplines collaborating in the investigation of the chromosomal effects of ionizing radiation is correlated, and the significance of these studies are related to the medical practitioner. (TSS)

10834 GENETIC VARIABILITY IN AEDES AEGYPTI (DIPTERA: CULICIDAE). II. MUTATIONS CAUSING STRUCTURAL MODIFICATIONS. VandeHey, Robert C.; Craig, George B. Jr. (Univ. of Notre Dame, Ind.). Ann. Entomol. Soc. Amer., 55: 58-69(Jan. 1962).

Mutations were isolated in the course of an analysis of variability in lab mosquito populations. Some mutations were obtained from stocks that were irradiated. Males about 48 hr postemergence were given doses of 2000 to 4000 R with either x rays or γ rays from a ^{60}Co source. These males were crossed to unirradiated females and their progeny were again crossed to unirradiated invididuals. The F_2 progeny from the latter cross was examined for modificiations. Detailed descriptions are given of the mutants. Most of the mutants showed reduced penetrance and variable expressivity, which made determination of the mode of inheritance of these factors difficult. In many cases, selection over several generations improved the penetrance of the structural factors. However, lines with 100% penetrance were developed in only a few cases. (TSS)

10835 RADIATION-INDUCED MUTANTS IN A JAPANESE WHEAT VARIETY, SHINCHUNAGA. Ichikawa, S. (Brookhaven National Lab., Upton, N. Y.). Wheat Inform. Serv. (Jap.), No. 19/20, 14(Mar. 1965).

Irradiation with 10 to 40 kR of γ rays from ^{60}Co of the dry seeds of Shinchunaga, a Japanese variety of wheat, induced 248 mutants. The mutants were classified into 6 groups: speltoid, compactoid, square-headed, lax-spiked, dense-spiked, and other mutant spike shapes. Other mutant characters were also observed, always in combination with the above mutants. Cytogenetic studies were performed on these mutants up to the X_8 generation. Speltoids were caused by a loss of gene, called Q, on the long arm of the 5A chromosome. They showed deficiencies of various sizes on the long arm, or were missing the whole arm or even the whole chromosome. Only one speltoid mutant was considered to be near the A-type speltoid of gene mutation type. Most compactoids, subcompactoids, and the related square-heads were due to an increase of the Q gene. An increase of the whole arm or of the whole chromosome was occasionally accompanied by a decrease of the homologous chromosome in these mutants. The subcompactoid and square-headed mutants were considered to be pentasomic and tetrasomic for the 5B or 5D chromosomes. Some square-heads that did not segregate compactoids were caused by a loss of the short arm of 5A chromosome or by deficiencies on the arm. Several lax-spiked mutants were missing the 6D chromosome or 1 arm of the chromosome. Other lax-spiked mutants were also missing other chromosomes. Some dense-spiked mutants were nullisomic for group 3 chromosomes, or were missing one of the arms of these chromosomes. Among other mutants, various chromosomal aberrations were observed. Evidently most of the radiation-induced mutants were caused by deficiencies or other chromosomal aberrations rather than by gene mutations, in contrast with spontaneous mutants. (BBB)

10836 SEQUENTIAL UV-INDUCED MUTATIONS IN SYNCHRONIZED CULTURES OF ESCHERICHIA COLI K-12. Kunicki-Goldfinger, Wladyslaw J. H.; Mycielski, Roman (Univ. of Warsaw). Acta Microbiol. Pol., 15: 113-18(1966).

The rate of uv-induced reversion mutations to prototrophy in a double auxotrophic (purine$^-$ and tryptophan$^-$) strain of E. coli K-12 was measured during growth of the bacteria in cultures synchronized with cold shock. In such synchronously growing cultures, DNA synthesis was restricted to small part of the division cycle. The maximum number of pur$^+$ mutants was formed before the commencement of DNA synthesis, and of try$^+$ mutants, just after the period of DNA synthesis. It is suggested that susceptibility of DNA to the mutagenic action of uv irradiation changes sequentially during replication, and/or is different at different stages of cell cycle, depending on the kind of structural change corresponding to a given mutation event. The nature of the mutations observed was not studied, and it is not known whether they were due to true reversion or to suppressor mutations. It is thus not possible to correlate the order of mutation induction with the order of position of the markers studied. (BBB)

10837 TRANSFER AND INTEGRATION OF MARKERS OF CHROMOSOME SEGMENT TRY–HIS E. COLI K-12 AFTER X-IRRADIATION. Pekhov, A. P.; Yudin, E. V. (Inst. of Experimental Biology, Moscow). Byull. Eksp. Biol. Med., 62: No. 9, 90-2(Sept. 1966). (In Russian).

The influence of different doses of x rays on genetic recombination of E. coli was studied. It was found that irradiation of E. coli Hfr H lead to a decrease in the frequency of recombinants Try$^+$S^r, Pro$^+$S^r, and His$^+$S^r, the effect being dependent on the dose and distance of the loci from the origin of chromosome segments. The greatest sensitivity to radiation was characteristic of the region Pro-Lac of transferable chromosome segment Try-His. (auth)

10838 X-RAY-INDUCED MUTATIONS IN EXTRACELLULAR PHAGE. Brown, D. F. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nature, 212: 1595-6(Dec. 31, 1966).

Samples of x irradiated phage and unirradiated controls were allowed to undergo single growth cycles in sensitive host bacteria so that any latent reverse mutations induced by the radiation would be expressed. The phage contained two genes for rapid lysis. The rII mutant, r9, was selected for use in these tests because of its low spontaneous reversion frequency. Experiments were carried out in which rII revertants were added to parental phage in numbers sufficient to mask any additive increase in frequency which might occur by mutation but small enough to reveal a multiplicative increase caused by selection. The results indicate that only a small part of the increase in rII frequency which was observed to be induced by radiation in control experiments can be accounted for by selection. It may be concluded that the greater part of this increase is a result of the induction of new rII mutations. (H.L.W.)

10839 STUDIES ON THE FACTORS AFFECTING THE REJOINING OF CHROMOSOME BREAKS PRODUCED BY X RAYS. II. EFFECTIVENESS OF DEOXYRIBONUCLEOSIDE TRIPHOSPHATES FOR REDUCTION OF X-RAY-INDUCED CHROMOSOME ABERRATIONS. Tanifuji, Shigeyuki; Saho, Takashi; Iwabuchi, Masaki (Hokkaido Univ., Sapporo). Idengaku Zasshi, 41: 389-94(Oct. 1966).

The combination experiments of x irradiation with some mixture solutions of various nucleotides were undertaken with the chromosomes of the ovular tissue cells of Trillium kamtschaticum. Thymidine triphosphate did neither reduce nor increase significantly both frequencies of simple and rejoined breaks produced by x rays. An equimolar mixture solution of three deoxyribonucleotides of dATP, dGTP, and dCTP did not also result in any significant difference in the frequency of breaks from the x ray control. When the four components commonly found in DNA or RNA were supplied as the form of nucleoside or nucleotide, there was a tendency toward the decrease of the frequency of breaks. The significant decrease in the frequency of simple breaks from that of the x ray control was recognized in the three cases of (dATP + dGTP + dCTP + dTTP)+, (dATP + dGTP + dCTP + UTP)+, and (ATP + GTP + CTP + dTTP)+ x ray treatments. These results suggest the involvement of DNA synthesis in the process of reunion of x-ray-induced breaks, at least in restitution to restore the original continuity of chromosomes. (auth)

10840 STUDIES ON THE FACTORS AFFECTING THE REJOINING OF CHROMOSOME BREAKS PRODUCED BY X RAYS. I. EFFECTS OF MITOMYCIN C, CHLORAMPHENICOL, ADENOSINE TRIPHOSPHATE AND NUCLEOSIDES ON THE YIELD OF X-RAY INDUCED CHROMOSOME ABERRATIONS. Iwabuchi, Masaki; Saho, Takashi; Tanifuji, Shigeyuki (Hokkaido Univ., Sapporo). Idengaku Zasshi, 41: 379-88(Oct. 1966).

The influence of mitomycin C, chloramphenicol, ATP, and various nucleosides on the yield of x-ray-induced chromosome aberrations was examined with the ovular tissue cells of Trillium kamtschaticum. Mitomycin C and chloramphenicol both brought about a significant increase of chromosome aberrations; ATP efficaciously reduced the aberration yield, thus indicating that the healing of chromosome lesions involves metabolic processes requiring energy supply; simultaneous application of one, two, or three kinds of nucleosides did not bring about any significant decrease in aberration frequency. Application of the nucleoside mixture containing the base components of DNA significantly decreased the aberration yield, but in the case of simultaneous application of four nucleosides of RNA components the frequency of aberrations in total did not reduce with a statistical significance, though there was seen a tendency that the aberration yield is reduced by the treatment. When the mixture of four nucleosides (adenosine, guanosine, cytidine, thymidine) or ATP were simultaneously administered with mitomycin C or chloramphenicol, the favorable action of the nucleoside mixture and ATP on the rejoining of chromosome breaks was completely arrested by these metabolic inhibitors. The experimental results suggested that both the syntheses of DNA and proteins are involved in the rejoining of x-ray-induced chromosome breaks, but do not necessarily give the clear-cut evidence as to which of them is more directly participated in the rejoining process. (auth)

10841 AUTOSOMAL TRANSLOCATIONS CAUSING MALE STERILITY AND VIABLE ANEUPLOIDY IN THE MOUSE. Lyon, Mary F.; Meredith, R. (Medical Research Council, Harwell, Eng.). Cytogenetics, 5: 335-54(1966).

Daughters of irradiated male mice were studied, with a view to finding the frequency of X-linked translocations and of autosomal aberrations causing male sterility. The treated males were given 600 rad x rays to the hind part of the body and offspring were obtained in the pre-sterile period. Forty-six of the 168 daughters studied were semi-sterile, and, of these, 26 carried translocations causing semi-sterility in both sexes, five carried translocations causing semi-sterility in females and full sterility in males, and five had translocations giving some semi-sterile and some sterile males. All the translocations were autosomal. The five translocations causing male sterility were studied more fully. All gave chain quadrivalents and some univalents at male meiosis, and three out of four showed recognisably abnormal chromosomes at mitosis. An unexpected finding in two of the translocations was the occurrence of live adult mice with 41 or 39 chromosomes. The extra or absent chromosome was thought to be one of the translocation products. Two of the aneuploid types were associated with mild phenotypic abnormality, and in all cases the males were sterile and the females had reduced fertility. This is the first report of autosomal translocations causing male sterility and of inherited autosomal aneuploidy in the mouse. (auth)

10842 PRODUCTION OF TWO DIFFERENT TYPES OF CHROMOSOME BREAKS BY X-RAYS. Iwabuchi, Masaki; Tanifuji, Shigeyuki; Ochiai, Hiroshi (Hokkaido Univ., Sapporo). Idengaku Zasshi, 41: 395-402(Oct. 1966).

X ray fractionation experiments on Trillium kamtschaticum indicated that two distinct types of chromosome breaks are induced by x irradiation, as judged from the time periods until the onset of rejoining. One of them was the breaks of which rejoining begins immediately and is complete within about 1 minute, and another was those which do not initiate rejoining until 30 to 60 minutes after irradiation. The possibility that the former breaks are of ionic nature and the latter are of covalent nature is discussed. (auth)

10843 THE EFFECT OF HETEROZYGOUS AUTOSOMAL INVERSIONS ON INDUCED EXCHANGES BETWEEN THE ATTACHED X AND Y CHROMOSOMES IN DROSOPHILA MELANOGASTER FEMALES. Lucchesi, John C. (Univ. of North Carolina, Chapel Hill). Genetics, 54: 1013-18(Oct. 1966).

Experimental evidence is presented of a significant increase of induced exchanges between the attached-X and Y chromosomes of Drosophila when heterozygous autosomal reversions are present in the genome. The presence of an inverted major autosome increases the frequency with which x-ray induced exchanges between the attached-X and Y chromosomes are recovered. The increase, magnified when both autosomes are structurally heterozygous, is manifested in three 3-day progeny broods but is increasingly marked in successive broods. Results are considered in terms of possible physiological and mechanical explanations. (H.G.D.)

10844 ON THE RELATION BETWEEN THE SOMATIC MUTATION SPECTRUM OF EPHESTIA KUEHNIELLA AND THE DEVELOPMENTAL STAGE OF THE IRRADIATED ANIMAL. Mueller, Ilse; Pentz, S.; Harte, C. (Univ., Cologne). Z. Vererbungsl., 97: 353-60(1966). (In German).

Earlier results indicated that the differences which were found in the radiation dose effect curves of four somatic mutations, affecting scale form and color, after 6-hr pretreatment at low and high temperatures, might be due to the fact that the pupae were irradiated at two different developmental stages, each exhibiting a different sensitivity pattern for the four mutant types. To further study this possibility, dose effect curves were established for pupae of the two age groups corresponding to the stages which were attained by the temperature treatments. Results showed that the exponent of the dose-effect curves was the same for all mutant types and independent of the age at irradiation. The age groups differed in their mutational spectra: the older pupae showed significantly more mutants of type-one epithelial cells (ES 1) and less of type ES 2 than the younger group. Both groups had identical frequencies of ES 3, and the differences between the ES 4 frequencies, which tended in the same direction as those of ES 2, were not significant. The results are discussed with regard to a possible difference in the specific radiosensitivity of epithelial cells and type-one scale stem cells. (BBB)

10845 DEPENDENCE OF THE NUMBERS OF 2-BREAK CHROMOSOME ABERRATIONS ON THE SIZE OF THE DOSE OF IONIZING RADIATION. Read, J. (Wakari Public Hospital, Dunedin, N. Z.). Radiat. Bot., 6: 489-98(Dec. 1966).

Mathematical expressions are derived that give the number of pairs of chromosome breaks separated by a distance less than h, when the breaks lie on the same straight track of an ionizing particle and when the breaks are randomly dispersed throughout the cell nucleus. A third expression covers the case where both circumstances are of about the same importance. This should apply with negligible error when the mean number of tracks that cross a nucleus exceeds 5 but not when this number approaches unity. An exact method for the last case is given, but it requires a computer. Application to the published numbers of 2-break chromosome aberrations produced by 3 MeV neutrons in Tradescantia microspores leads to a value of h, the distance within which breaks must be formed to produce a 2-break aberration, which is close to 1 μ. The mean separation of breaks along the ionizing tracks equals 4.8 μ, and the fraction of all the cases where two breaks are produced closer than h that results in observable 2-break aberrations is 0.335. The number of primary breaks is about 10 times larger than those involved in recognizable aberrations, i.e., about 90% of the primary breaks restitute. (auth)

10846 INDUCED MUTATIONS IN PLANT BREEDING. Gaul, Horst (Max-Planck-Institut fuer Zuechtungsforschung, Cologne). pp 689-709 of Genetics Today. Oxford, Pergamon Press, 1964.

A review of the uses of ionizing radiations and chemical agents for induction of mutations in plants of economic significance with particular emphasis on barley mutations is presented. Early reports on radioinduced barley mutations indicated that there was not a linear relationship between an increase in mutation frequency with radiation dose. Due to erroneous mutation measurement methods medium and high doses were used, when either a

saturation-effect or a decrease in mutation rates was observed. Linear or exponential dose relation was found in experiments after x-ray exposure of barley seeds and after ethylmethane-sulfonate (EMS) treatments. When extremely high doses of both x ray and EMS were applied, the exponential increase of mutation rates was observed to be the highest obtainable killing rate (99% of treated seeds); therefore, the highest possible dose should be used for inducing mutations in plant breeding programs. The developmental stage of the plant in which the mutagen is applied was found to change the mutation spectrum. For a broader use of mutation breeding it was deemed necessary to increase the efficiency of mutation induction as well as the methods of selection. With EMS treatments, chlorophyll mutation rates were induced and were at least five times higher than those obtained with x irradiation. Moreover, there were more vital mutations per chlorophyll mutation after EMS treatment than after x irradiation. Only in rare cases could large mutations be utilized directly and were noted as being very limited in usefulness for mutation breeding. Experiments on small mutations showed that genetic variance of quantitative characters can be radioinduced. These experiments also indicated that small mutations occurred much more often than large mutations. Some positive small mutants have been selected. (TSS)

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Refer also to abstracts 10420, 10460, 10729, 10916, and 12160.

10847 (AD-629926) INTEGRATED GUIDANCE FOR SHELTER MANAGEMENT. PLANNING A GROUP SHELTER. Smith, Robert W.; Lasky, Mary Ann (American Institutes for Research, Pittsburgh, Pa. Inst. for Performance Technology). June 1965. Contract OCD-PS-64-57. 31p. (AIR-D93C-6/65-TR(1)). CFSTI $2.00 cy, $0.50 mn.

10848 (AD-629935) INTEGRATED GUIDANCE FOR SHELTER MANAGEMENT. SHELTER MANAGER'S GUIDE. Brandegee, Ada S.; Bend, Emil (American Institutes for Research, Pittsburgh, Pa. Inst. for Performance Technology). June 1965. Contract OCD-PS-64-57. 26p. (AIR-D93B-6/65-TR(c-1)). CFSTI $2.00 cy, $0.50 mn.

The purpose of the project was to develop and evaluate in-shelter guidance materials which any fallout shelter manager, trained or untrained, could use as an operational management guide. An initial version of the "Shelter Manager's Guide" was used by both trained managers and emergent leaders in 24- and 48-hour habitability studies conducted by the American Institutes for Research. After the "Shelter Manager's Guide" was revised, it was evaluated in an experimental comparison with other types of guidance materials. The final product is arranged by priority of management decisions and actions within five shelter phases: Entry, Initial Organization and Operations, Routine, Temporary Emergence, and Contingencies (emergencies). It provides the management decision and actions necessary to organize and operate a fallout shelter, and supplies the information which the manager needs to support these decisions and actions. (auth)

10849 (AD-629939) INTEGRATED GUIDANCE FOR SHELTER MANAGEMENT. VOLUME I. INTRODUCTION TO SHELTER MANAGEMENT. Bend, Emil; Collins, Robert A. (American Institutes for Research, Pittsburgh, Pa. Inst. for Performance Technology). June 1965. Contract OCD-PS-64-57. 300p. (AIR-D93B-6/65-RP(b)). CFSTI $6.00 cy, $1.50 mn.

The volume is designed as a training text. It provides an overview of the scope and nature of the shelter manager's duties and responsibilities. The text emphasizes general management principles and considerations, rather than specific operational procedures. (auth)

10850 (AD-629940) INTEGRATED GUIDANCE FOR SHELTER MANAGEMENT. VOLUME II. PLANNING A GROUP SHELTER. A Planning Guide. Smith, Robert W.; Lasky, Mary Ann (American Institutes for Research, Pittsburgh, Pa. Inst. for Performance Technology). June 1965. Contract OCD-PS-64-57. 167p. (AIR-D93C-6/65-RP). CFSTI $5.00 cy, $1.00 mn.

The volume deals with the peacetime responsibilities of the shelter manager which focus upon the achievement and maintenance of a state of operational readiness of a shelter facility. The planning guide discusses the principal factors that must be considered in planning and developing a group shelter. It also identifies methods for meeting the requirements associated with these factors, and presents specific information that would permit the shelter manager to select methods appropriate to his needs. (auth).

10851 (AD-629941) INTEGRATED GUIDANCE FOR SHELTER MANAGEMENT. VOLUME III. SHELTER MANAGER'S GUIDE. Guidance for In-Shelter Use. Brandegee, Ada S.; Bend, Emil (American Institutes for Research, Pittsburgh, Pa. Inst. for Performance Technology). June 1965. Contract OCD-PS-64-57. 213p. (AIR-D93B-6/65-RP(c)). CFSTI $6.00 cy, $1.25mn.

The volume was developed for use during the period of shelter occupancy. This means that the content, as well as its organization and presentation, was designed for optimum usefulness under emergency conditions. The Guide lists priority-ordered management actions and decisions, arranged according to the phases of a shelter stay. (auth)

10852 (AD-630015) INTEGRATED GUIDANCE FOR SHELTER MANAGEMENT. INTRODUCTION TO SHELTER MANAGEMENT. Bend, Emil; Collins, Robert A. (American Institutes for Research, Pittsburgh, Pa. Inst. for Performance Technology). June 1965. Contract OCD-PS-64-57. 17p. (AIR-D93B-6/65-TR(b-1)). CFSTI $1.00 cy, $0.50 mn.

The product of the research described in this technical report was a training text entitled "Introduction to Shelter Management." The text was designed for use in end-product shelter management training. The technical report also briefly describes several different approaches to shelter management training into which the training text can be fit. The recommended approach was to use the text as background reading, and to use class meetings for discussions of specific problems and guidance pertinent to the particular group of shelter manager trainees attending the course. The content and organization of the textbook are briefly described in the report, and suggestions are offered for further research in the field of shelter management training. (auth)

10853 (AD-630423) EXPERIMENTAL STUDIES OF FALLOUT SHELTER VENTILATION REQUIREMENTS. Final Report October 1962–September 1964. Behls, H. F.; Madson, C. A. (General American Transportation Corp., Niles, Ill. General American Research Div.). Oct. 1965. Contract OCD-PS-64-201. 53p. (GARD-1268-40). CFSTI $3.00 cy, $0.50 mn.

The results of two years' field testing of fallout shelters is reported herein. Simulated occupants (Simocs) and forced flow conditioned air were used to duplicate emergency environmental conditions. Nine tests have previously been documented in detailed Interim Reports. Based on field measurements of temperature, humidity and heat flux, and supplemented by an analytical computer program, an "adiabatic" procedure is recommended to predict shelter environmental conditions. This adiabatic procedure neglects heat transmission through the shelter boundary surfaces and can predict shelter effective temperatures to within 2F. The procedure is conservative in that it will over-estimate the shelter temperature for all shelters tested. (auth)

10854 (AE-253) REPORT ON THE PERSONNEL DOSIMETRY AT AB ATOMENERGI DURING 1965. Edvardsson, K. A. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Oct. 1966. 14p. Dep. mn.

Results of personnel dosimetry at AB Atomenergi during 1965 are presented. No doses exceeding the ICRP recommendations were reported. The average external whole-body dose during the year was 60 mrem. Data were obtained from 31,200 γ films, 5850 neutron films, 2067 urine analyses, and 692 whole-body measurements. (H.G.D.)

10855 (CEA-R-3083) EVALUATION RAPIDE DE LA DOSE DE NEUTRONS A LA SUITE D'UN ACCIDENT DE CRITICITE PAR MESURE DE L'ACTIVITE DE ^{24}Na. (Rapid Evaluation of the Neutron Dose Following a Criticality Accident by Measurement of ^{24}Na Activity). Estournel, Roger; Henry, Philippe (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule); Beau, Paul; Ergas, Alain (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Oct. 1966. 32p. (In French). Dep. mn.

It is possible to evaluate the personal dose received by external measurement of the gamma activity of ^{24}Na induced in human organs by a neutron flux during a criticality accident. Detectors designed for everyday use in health physics can be applied to these measurements, and this is described in the first part of the work. The response of a certain number of induced-activity detectors is presented. The induced activity-dose relationship is studied theoretically in the second part taking into account the neutron spectrum to which the individual has been subjected. The characteristic spectra of three possible types of accident were used for deducing this relationship. The results obtained show that the method is sufficiently sensitive for present purposes. (auth)

10856 (CEA-R-3086) DESCRIPTION D'UN DISPOSITIF PERMETTANT LA CONTAMINATION D'ANIMAUX DE LABORATOIRE PAR INHALATION D'AEROSOLS RADIOACTIFS. (Device for Contaminating Laboratory Animals by Inhalation of Radioactive Aerosols). Lutz, Michele; Rouvroy, Huguette (Commis-

sariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct. 1966. 28p. (In French). Dep. mn.

An apparatus was designed for studies on inhalation of radioactive aerosols by laboratory animals. The device consists of a sphere to which an aerosol generator is attached, appropriate containers for animals, and an atmospheric sampling system. During the contamination procedure, the sphere is placed in a glove box protected by an introduction chamber fitted with locking access lids. Results are presented of experiments in which the device was used to expose rats to a plutonium oxide aerosol. (H.G.D.)

10857 (CLOR–50D) OBSERVATION OF THE GAMMA-RAY BACKGROUND IN WARSAW WITH A SCINTILLATION STATIC MONITOR. Pensko, J. (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1966. 18p. Dep.

The systematic observations of gamma background dose rates were carried out during the years 1962-1965 in Warsaw. The measurements were performed by means of scintillation counter NaI/Tl/$2\frac{1}{4}$" × 2". The dose rate is greater in summer than in winter. The rain-showers bring the temporary increase of gamma background, sometimes to about 80 percent of the mean value. The dose rate from fission products amounted to about 25 percent of natural background radiation in the autumn 1962, to about 70 percent in the summer 1963, and to about 39 percent in the summer 1964. The contribution to gamma background radiation from radon daughters contained in the atmosphere amounted to about 1.8 percent in the summer 1964, and to about 5.5 percent in the autumn and winter 1964/65. (auth)

10858 (CLOR–55) ^{90}Sr AND ^{137}Cs CONTENT IN SOME FOODSTUFFS, POLAND, 1962. Bilkiewicz, J.; Szepke, R. (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1966. 26p. Dep.

Cesium-137 and ^{90}Sr were determined in milk, cottage cheese, bread, potatoes, cabbage, beef, and marine and freshwater fish. Hazards of human intake of ^{137}Cs and ^{90}Sr via diet, water, and air were evaluated and determined to be 1.36 and 22% respectively of the maximum permissible values for internal radiation exposure. (H.G.D.)

10859 (CMN-Pub-2/65(Suppl.1)) BASES BIOLOGICAS DA RADIOISOTOPIA E NOCOES DE HIGIENE DAS RADIACOES. ANEXO, I. DOSIMETRIA INTERNA. (Biological Bases for Radioisotope Use and Concepts of Radiation Protection. Supplement I. Internal Dosimetry). Barbosa Correa, Carlos (Sao Paulo Univ. (Brazil). Centro de Medicina Nuclear). 1965. 21p. (In Portuguese). DTIE.

The dose units used in internal dosimetry are described. The physical and biological factors that determine the concentration of radioisotopes administered to tissues are discussed. The method used for the dose calculation is outlined. (J.S.R.).

10860 (COO–1199-10) STUDY OF RAINOUT OF RADIOACTIVITY IN ILLINOIS. Progress Report No. 5. Bradley, Wayne E.; Feteris, Pieter J. (Illinois State Water Survey, Urbana). Dec. 1966. Contract AT(11-1)-1199. 44p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

During the summer of 1965 network water sampling for radioactivity was continued. In addition, surface air sampling plus airborne water and air sampling were carried out. The project was undertaken in an effort: to evaluate changes in radioactivity concentrations in precipitation between cloud-base and the ground; to ascertain the relationship between air and rainwater concentrations; and to seek further information on the source of the initial high concentration of radioactivity frequently observed in the 1962 to 1964 studies. An airborne system for sampling atmospheric water vapor was developed to collect water vapor for tritium analyses. The aircraft sampling system as well as the laboratory backup system are described. (auth)

10861 (HASL–174) FALLOUT PROGRAM QUARTERLY SUMMARY REPORT, SEPTEMBER 1–DECEMBER 1, 1966. Hardy, Edward P. Jr.; Rivera, Joseph (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Jan. 1, 1967. 206p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Current data are presented from the HASL Fallout Program, EURATOM Joint Nuclear Research Center, Argonne National Laboratory, the Department of Scientific and Industrial Research in New Zealand, Isotopes, Inc., and the Environmental Science Services Administration. Radionuclide levels in fallout, milk, tapwater, and surface and high altitude air, are given in tabular form. The initial section consists of interpretive reports and notes covering the following topics: fallout collection on a wet surface, relative efficiency of a ship collector for precipitation and fallout, increasing ^{238}Pu to ^{239}Pu ratio in surface air at Ispra, Italy, quality control program at HASL, and ^{137}Cs in tri-city diets during 1965. A bibliography of recent publications related to radionuclide studies is also presented. (auth)

10862 (HASL–174(App.)) FALLOUT PROGRAM QUARTERLY SUMMARY REPORT, SEPTEMBER 1–DECEMBER 1, 1966. [Hardy, Edward P. Jr.; Rivera, Joseph] (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Jan. 1, 1967. 206p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Data are tabulated on the content of ^{89}Sr and ^{90}Sr in fallout samples collected at world wide sites, fission product and activation product radionuclides deposited at selected sites, and the content of ^{90}Sr in milk and water supplies in New York City, 1963 to 1967. (C.H.)

10863 (HW–59706) DOSE RATES FROM CANNED URANIUM. Carter, L. A. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Mar. 12, 1959. Contract AT(45-1)-1350. 15p. DTIE.

Data are presented on the problem of establishing surface dose rates for uranium handling. The true dose rate from 95% equilibrium canned metal measured through plastic-coated gloves is about 15 mrad/hr. Expressed in timekeeping units, this is equivalent to 1 mrad/hr. Therefore, the background in the work area during makeup of charges and charging is such that the dose rate to the eyes will be the limiting factor, with the whole-body penetrating dose-rate next in significance. (H.G.D.)

10864 (LA–3622) TEST CELL C SHIELDING STUDY: KIWI B4D-202. Ahlquist, A. John; Dummer, Jerome E. (Los Alamos Scientific Lab., N. Mex.). Nov. 1966. Contract W-7405-eng-36. 27p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Gamma and neutron doses at 71 and 19 stations, respectively, in the Test Cell C complex at the Nuclear Rocket Development Station were measured during the full-power run of the Kiwi B4D-202 reactor to determine shielding effectiveness of the test cell structures. (auth)

10865 (MLM-1335) ENVIRONMENTAL MONITORING REPORT: JULY–DECEMBER 1965 AND 1965 SUMMARY. Adams, P. C.; Anderson, H. F. (Mound Lab., Miamisburg, Ohio). Feb. 28, 1966. Contract AT(33-1)-Gen-53. 18p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The concentration of radioactive materials detected in the environment surrounding Mound Laboratory, Miamisburg, Ohio is presented for the second half of 1965 and a summary is presented for the entire year. The concentration of radionuclides from Mound Laboratory in the Great Miami River and in the environmental air was within the Radioactivity Concentration Guides recommended by the Federal Radiation Council. (auth)

10866 (MLM–1356) ENVIRONMENTAL MONITORING REPORT: JANUARY–JUNE 1966. Anderson, H. F.; Sheehan, W. E. (Mound Lab., Miamisburg, Ohio). Sept. 1, 1966. Contract AT(33-1)-Gen-53. 22p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The concentration of radioactive materials detected in the environment surrounding Mound Laboratory, Miamisburg, Ohio is presented for the first half of 1966. The concentration of radionuclides from Mound Laboratory in the Great Miami River and in the environmental air was within the standards specified by the Atomic Energy Commission. (auth)

10867 (NLCO–986) BIOASSAY ASPECTS OF A UF_6 FUME RELEASE. Boback, M. W.; Heatherton, R. C. (National Lead Co. of Ohio, Cincinnati). [1966]. Contract AT(30-1)-1156. 17p. (CONF-661018–4). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 12th Annual Bioassay and Analytical Chemistry Meeting, Gatlinburg, Tenn.

About 3800 pounds of uranium as UF_6 escaped from a heated 10-ton cylinder. This paper describes the cause of the release as determined by an investigation team, emergency actions taken, consequences of the release, and several uranium excretion patterns exhibited by exposed employees. (auth)

10868 (NP–16324) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 4, Number 7. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.). July 1966. 26p. Dep. mn.

Data are presented on fallout monitoring in Canada during June 1966 and on reactor environment monitoring for the same period. Average fallout values for June 1966 were generally below those of the previous month. The average concentrations of ^{137}Cs and ^{90}Sr in liquid milk were 50 pCi/l and 20.3 pCi/l respectively, compared to 70 pCi/l and 20.7 pCi/l in May 1966. Activities of samples taken in the vicinities of Canadian reactors were in general agreement with observations made in the fallout program and did not show any anomalies that could be attributed to a release of contamination from the reactors. (H.G.D.)

10869 (NP–16371) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 4, Number 6. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.). June 1966. 42p. Dep. mn.

Data presented on radiostrontium and radiocesium in Canadian

tap water supplies and on fallout monitoring and reactor environment monitoring for May 1966. Results of ^{89}Sr, ^{90}Sr, and ^{137}Cs determinations on the tap water of 13 Canadian cities are reported for the period July 1964 to October 1965. An attempt was made to evaluate the effect of the factors that may cause differences between the results obtained for different cities. Observed levels of radioactivity throughout the water sampling program were well below the maximum permissible concentrations recommended by the ICRP. The average fallout values for May 1966 showed slight increases throughout the program compared to values recorded the previous month. Small amounts of fresh fission products resulting from the Chinese test of May 9, 1966 were detected in the air and precipitation samples. The observed values were negligible, however, the maximum amount of ^{140}La detected in air filter samples being 0.37 pCi/m^3. All data collected in the reactor environment monitoring for May 1966 were in general agreement with observations made in the fallout program, and no anomalies were shown that could be attributed to a release of contamination from the reactors. (H.G.D.)

10870 (NP–16383) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 4, Number 9. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.). Sept. 1966. 37p. Dep. mn.

Data are presented on ^{137}Cs in the Canadian North for the first half of 1966 and on fallout and reactor environment monitoring for August 1966. Activity measurements in tap water made for January to July 1966 are included. Average ^{137}Cs concentrations in meat samples during the first half of 1966 were close to values obtained during the first half of 1965 but about half of the value obtained during the same period of 1964. Body burdens of ^{137}Cs in man were: greater for women than for men in all diet classes; showed a peaking effect for persons with a weight of 141 to 156 lbs; and did not vary markedly with age. The average fallout values for August 1966 were generally below those of the previous month. Data collected on the Canadian reactor monitoring program were in general agreement with observations made in the fallout program and did not show any anomalies that could be attributed to a release of contamination from the reactors. (H.G.D.)

10871 (NP–16447) STATISTICAL ANALYSIS OF RADIATION EXPOSURE DATA FROM PERSONNEL FILM MONITORING RECORDS. Khandkar, Ram N. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.). July 1963. 45p. (RPD–32). Dep. mn.

Data collected by the Radiation Protection Division of the Department of National Health and Welfare between 1958 and 1960 were analyzed. The minimum reported exposure of less than 40 mR was examined in terms of its contribution to the total cumulative dose. The results of a special investigation indicate that a mean value of 4.6 mR can be realistically applied to all films in this dose category. Evidence of increasing awareness among radiation personnel of the possible hazard to health is apparent from the analysis of data presented in the study and is shown in the gradual reduction of the average dose per film. The reduction is largely attributed to a relative increase in low-dose exposures. Industry consistently showed the highest average dose per film, a value that is, however, steadily declining. For groups of individuals the relative risk of radiation exposure can be expressed in either of two ways: by comparing the average dose per film with the average permissible dose of 200 mR derived from the ICRP., or by comparing the average annual cumulative dose per individual with 5000 mR as recommended by the ICRP. Both techniques were used, and in most cases the average doses amounted to a small percentage of the reference dose. For industry the percentage was somewhat higher, especially in 1958. (H.G.D.)

10872 (NP–16458) BLAST-CLOSURE VALVES. Final Report. Hughes-Caley, F.; Kiang, R. (Stanford Research Inst., Menlo Park, Calif.). Aug. 1965. Contract OCD-PS-64-201. 118p. CFSTI $3.00 cy, $0.65 mn.

Four candidate blast closure valves for the ventilation openings of the domestic type personnel shelter are investigated theoretically. The calculated closing times of all four are one-tenth or less of the required closing time, which is defined as the longest time the closure valve may stay open before the pressure build-up in the shelter exceeds the tolerable limit. For a 50-person shelter with an assumed tolerable limit of 5 psig pressure rise in the shelter, the longest required closing times for 100, 80, 60, and 40 psig ambient overpressures are 60, 75, 110, and 140 msec, respectively. Since analysis indicates that all four of the investigated candidate valves should close at rates much faster than these, the choice among valves will be determined only on the basis of reliability and cost. If sufficient confidence can be established in the physiological data given, the tolerable limit of pressure rise can be elevated to 23 psig. In that case, ventilation openings will not require blast closures provided of course that the openings are well protected from penetration of blast-borne missiles and debris that might damage ventilating and other equipments or injure personnel. (auth)

10873 (NYO-3364-27) SEASONAL VARIATIONS IN THE ^{137}Cs CONCENTRATIONS IN COW'S MILK, 1963–1966. Madshus, Kjell (Norsk Hydro's Inst. for Cancer Research, Oslo); Stroemme, Aksel (Norsk Radiumhospital, Oslo); Koren, Kristian (Statens Radiologisk-Fysiske Laboratorium, Oslo (Norway)). Contract AT(30-1)-3364. 10p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Seasonal variations in the ^{137}Cs contamination in cow's milk were studied during the period 1963 and 1966. Variables identified in contamination levels were the rate of intake, grazing conditions, use of supplementary fodder, and rate of fallout. Milk samples from 30 Norwegian dairies were analyzed. Minimum ^{137}Cs concentrations were observed during the months of February, March, and April, increasing suddenly in May and continuing to increase until August when a sharp peak was reached. Food was the chief source of ^{137}Cs in cow's milk. Concentrations in drinking water were negligible and were very small in supplementary fodder. Results confirm the belief that ^{137}Cs-concentrations in cow's milk are presently declining. (H.G.D.)

10874 (ORNL-NSIC–20) INDEXED BIBLIOGRAPHY OF CURRENT NUCLEAR SAFETY LITERATURE–7. (Oak Ridge National Lab., Tenn.). Nov. 1966. Contract W-7405-eng-26. 173p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Included are references collected since 1963 by the Nuclear Safety Information Center. The bibliographic items are sorted into 19 categories of nuclear safety information and selector-term and author indexes are included. (H.D.R.)

10875 (ORNL-NSIC–31) INDEX TO NUCLEAR SAFETY. A TECHNICAL PROGRESS REVIEW BY CHRONOLOGY, PERMUTED TITLE, AND AUTHOR, VOL. 1, NO. 1 THROUGH VOL. 7, NO. 4. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 65p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

10876 (ORNL-P–2516) SCINTILLATION EXTRAPOLATION DOSIMETRY OF SMALL BETA-EMITTING SOURCES. Wilkie, W. H.; Fish, B. R. (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 24p. (CONF-661005–23). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Symposium on Solid-State and Chemical Radiation Dosimetry, Vienna, Austria.

A technique is described which may be utilized for obtaining values of absorbed dose to tissue-equivalent volumes approaching the volume of individual tissue cells. The method incorporates a series of scintillators (anthracene or NE-102-A plastic) with dimensions ranging from 11-mm diameter × 0.5-mm thick to 1-mm diameter × .032-mm thick mounted on lucite light pipes. Pulse-height spectra are obtained using each scintillation assembly with absorber thicknesses from zero to several hundred mg cm^{-2}. These are converted to energy spectra using a computer program to apply appropriate corrections, and the absorbed dose is calculated. Individual dose measurements are then assembled into extrapolation curves which relate dose to tissue volumes at specified absorber thicknesses. This technique is useful for measurements with sources of activity in the range of 0.05 to 500 μCi, which is below the range for which an ionization extrapolation chamber can be used. A comparison is made between the anthracene and plastic scintillation assemblies, and the corrections necessary to convert pulse-height data to absorbed dose are discussed. The advantages and difficulties of this method are evaluated and compared with similar measurements using an air ionization extrapolation chamber of the Loevinger design. (auth)

10877 (ORNL-P–2656) RESEARCH SAFETY. Hoy, H. C. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 12p. DTIE.

Problems of protection and safety have arisen with the development of complex research machines at Oak Ridge National Laboratory. The lack of knowledge concerning the operating parameters, such as voltages, magnetic forces, vacuum handling ability, and temperature extremes, has contributed to hazards to personnel working with these machines. A set of Electrical Safety Guidelines has been written by research personnel for the various types of equipment used in operations at ORNL. Injuries resulting from electricity are classified into 2 types, shock and radiation. The damage from shock is the result of current passing through or on the surface of the body. Radiation injuries are caused by electromagnetic waves and by visible or invisible light. An outline of electrical safety guides is included. The responsibilities of the supervisor and other personnel are listed. National standards and supplementary standards are given. Power supply protective measures are described. Effects of various current ranges on the heart and respiration are described. The mouth-to-mouth method of artificial respiration is explained. (H.L.W.)

10878 (PEL–123) ENVIRONMENTAL RADIOACTIVITY AT THE NATIONAL NUCLEAR RESEARCH CENTRE, PELINDABA. Report for the Year 1965. Van As, D. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Oct. 1966. 61p. Dep. mn.

Results of environmental monitoring at the Safari I site in Pelindaba, South Africa during 1965 are summarized. The background radioactivity was determined over 18 months. No increase in the environmental activity around Pelindaba was detected. (H.G.D.)

10879 (USNRDL-TR-1040) PARAMETERS GOVERNING URBAN VULNERABILITY TO FIRE FROM NUCLEAR BURSTS, Phase I. Renner, R. H.; Martin, S. B.; Jones, R. E. (Naval Radiological Defense Lab., San Francisco, Calif.). June 30, 1966. 335p. CFSTI $3.00 cy, $0.65 mn.

The parameters governing the fire vulnerability of U.S. urban areas from nuclear bursts were identified, defined, and evaluated in terms of their relative importance, interactions, and sensitivity characteristics. The results will be useful in fire-vulnerability assessment studies. (36 references.) (auth)

10880 (USNRDL-TR-1106) EXPOSURE RATES FROM THE PRODUCTS OF FAST NEUTRON FISSION OF ^{235}U AND ^{238}U AT SELECTED TIMES AFTER FISSION. Bunney, L. R.; Sam, D. (Naval Radiological Defense Lab., San Francisco, Calif.). Oct. 28, 1966. 19p.

The exposure rates/fission/cm^2 at three feet above a uniformly contaminated plane were calculated for nine selected times ($^1/_4$ to 72 hr) after fast neutron fission of ^{235}U and ^{238}U. The calculations were made from experimentally determined gamma spectra of the fission products. (auth)

10881 (USNRDL-TRC-79) , POSTATTACK SANITATION, WASTE DISPOSAL, PEST AND VECTOR CONTROL AND THE EFFECTS OF FALLOUT IN WASTE WATER AND SEWER SYSTEMS, Phase II. (Engineering-Science, Inc., Arcadia, Calif.). Jan. 1967. Contract N228-(62479)-68147. 101p.

Information on the magnitude, character, and timing of postattack sanitation operations for the San Jose Metropolitan Area of California is presented, and the effectiveness of these overall operations on maintaining disease incidence at levels that will not be detrimental to postattack recovery are assessed. Information on the sedimentary effects of fallout washed into drainage systems is also presented including: a method to determine the effects; and the sections of the systems that are most likely to experience sediment build-up. The results of the analysis of the postattack sanitation operations in the Study Area indicate approximately 60 percent of the waste collection vehicles will be damaged, but due to increased use of the surviving vehicles and the postattack reduction of household refuse production, no detrimental effect on the overall postattack recovery of the area is expected. The study of fallout transport in drainage systems indicates that sediment build-up will occur when the flow rate per unit of width is decreased, as in the case of water exiting from a catch basin connector pipe into a main line. (auth)

10882 (ORNL-tr-1386) DANGER OF ACCIDENTAL ELECTRICAL CONTACTS. Reale, A.; Salvadori, P. Translated for Oak Ridge National Lab., Tenn., from Giorn. Fiz., 6: 243-58(1965) 26p. Dep. mn. JCL $2.60 fs, $0.86 mf.

Effects to be expected as a result of contact with a conductor under voltage were examined. A discussion of factors such as effective potential difference and current intensities in relation to resistance of the human body is presented. The danger of an electrical current is determined by its intensity rather than by the applied potential. With a direct current, the danger is much smaller compared with an alternating current of 60 Hz (sensitivity maximum) of identical intensity, even if its effect on the lesions produced is greater. The importance of the frequency and form of a current in the determination of its danger is discussed. A discussion of the influence of the duration of contact and the path of the current in the body is given. The most serious danger is ventricular fibrillation which requires that the current, in addition to having sufficient intensity, must traverse the victim during a definite period of the cardiac cycle. A discussion of the current intensity as the determining element in the consequences of electrical shock is given. The intensity range is divided into five categories according to the average effects on the subject. The first category includes currents which are absolutely not perceived. The second includes those which produce a slight sensation of shock; weak muscular contractions and nerve shock in the arm occur. The third includes those which produce a painful effect with a consequent muscular contraction; irregular heart rhythm, increase of blood pressure, and reversible cardiac arrest occur; there is no possibility of self liberation. The fourth includes immediately dangerous currents producing ventricular fibrillation and irreversible cardiac arrest. The fifth includes currents which are always dangerous, but which have different consequences such as sideration of nerve centers, increase of blood pressure, arrhythmia and reversible cardiac arrest due to respiratory paralysis. Practical examples for the evaluation of the risk of accidental contact are given. (H.L.W.)

10883 PERSONNEL PROTECTION FROM HIGH-ENERGY LASERS. Goldman, Leon; Hornby, Peter (Children's Hospital Research Foundation, Cincinnati). Amer. Ind. Hyg. Ass. J., 26: 553-7(Nov.–Dec. 1965).

Prevention of eye and skin injuries in the use of lasers is considered from the point of view of personnel control and area control. The first concern in laser protection is the eye, not only from impact of the direct beam but also from the reflection from surfaces. Procedures for eye protection are discussed. Area control includes use of dark, dull, nonreflecting surfaces in the lab, use of extensive black, heavy felt drapes, and use of devices to attempt to focus on the target area and to observe the effects on the target area without direct observation of the target. Personnel protection for the eye requires a goggle with sufficient protective material and so fitted that stray light cannot come in from any angle. It is recommended that as a rule personnel not work in the dark, since the ratio of eye acceptance area in the dark to that in the light is 16:1. (TSS)

10884 RADIOTOXICOLOGICAL CONTROL IN THE MILITARY NUCLEAR CENTER (C.A.M.E.N.). Pulcinelli, Mario; Carrai, Mario (Centro Applicazioni Militari Energia Nucleare, Pisa, Italy). Minerva Med., 56: 3947-9(Nov. 14, 1965). (In Italian).

The health physics methods adopted in the Center for Applications of Military Nuclear Energy, Pisa, are briefly outlined and the organization of the radioprotective service is sketched. (J.S.R.)

10885 LASER WARNING SIGN. De Ment, Jack; Jarabak, John P.; Phatak, Nilkanth M.; Kinersly, Thorn (Univ. of Oregon, Portland). J. Amer. Med. Ass., 190: 253(Oct. 19, 1964).

About 500 groups in the United States, involving as many as several thousand people, now work with lasers. Many investigators apparently inadequately appreciate the energy levels of such devices. There is increasing concern about the little-known dangers from acute, and especially chronic, exposure to laser light or coherent radiation, including possible visual impairment and laser-induced blindness. As an analog of the universally used, recognized, and accepted radioactivity warning sign, a standard laser-light warning sign is proposed. This is an appropriate and distinctive laser symbol together with the word CAUTION or DANGER above that symbol and the expression LASER LIGHT below the device. (TSS)

10886 DEFENSE AGAINST RADIOACTIVE FALLOUT ON THE FARM. U. S. Dept. of Agr., Farmers' Bull., No. 2107, 14p(1965).

General information is provided on the effects of thermonuclear explosions, especially of fallout radiation, and on ways of protecting land, livestock, and crops from fallout, and emergency measures to be taken before, during, and after an attack. (TSS)

10887 LASER: MEDICAL AND INDUSTRIAL HYGIENE CONTROLS. Tebrock, H. E. (Sylvania Electric Products, New York); Young, W. N.; Machle, W. J. Occup. Med., 5: 564-7(Dec. 1963).

Biological effects of laser radiation are discussed and hazards of laser use are considered from a health or occupational environmental control viewpoint, especially of problems existing in 3 different areas; those of the high-powered, pulsed, solid-state lasers; the lower-powered, continuous-wave gas laser; and junction diode lasers. (TSS)

10888 OCCUPATIONAL SAFETY WITH LASER (OPTICAL MASER) BEAMS. Solon, Leonard R. (Radioptics, Inc., Yonkers, N. Y.). Arch. Environ. Health, 6: 414-17(Mar. 1963).

The nature of laser irradiation and its biological effects are discussed preliminary to a discussion of how lasers work, where they may be encountered in the occupational environment, and what may be done to safeguard persons against inadvertent exposures to elevated intensities of laser light sources. Some practical guidelines are set forth for the occupational safety specialist in protecting lab and plant personnel, occupationally connected with laser development or laser applications. (TSS)

10889 ^{90}Sr CONTENT OF DECIDUOUS TEETH OF CHILDREN. Rosenthal, Harold L.; Bird, John T.; Gilster, John E.; Pinto, P. V. C.; O'Neill, Sheila (Washington Univ., St. Louis). J. Dent. Res., 45: 343-9(Mar.-Apr. 1966).

To determine the usefulness of deciduous teeth as a measure of ^{90}Sr body burden, studies were undertaken to define the variation in the ^{90}Sr content of the various types of deciduous teeth. The ^{90}Sr content of deciduous tooth crowns increased from 0.15 to 4.7 pC ^{90}Sr/g Ca between 1947 and 1958, respectively, for children born in the St. Louis area and who were bottle-fed from birth. The variation of ^{90}Sr content in deciduous incisors, cuspids, and first and second molars, between carious and sound teeth or be-

tween teeth from children who were breast-fed or bottle-fed during the time of tooth formation, was less than 30%. This small variation suggests that pooled samples of tooth crown, without regard to these classifications, may adequately serve as a measure of ^{90}Sr body burden during the time of tooth formation. For the teeth of children who were bottle-fed, a relation between the ^{90}Sr content of tooth crown (C_t) and the diet (C_d) is described by the equation $C_t = XC_d$, where the slope (X) must be determined experimentally. The value of X was 0.59 for sound incisors, 0.69 for carious first molars, 0.76 for sound cuspids, and 0.77 for carious second molars. This relation makes it possible to estimate the dietary ^{90}Sr content from tooth values for years prior to the initiation of dietary ^{90}Sr estimations. (BBB)

10890 RADIATION DOSES TO ROENTGENOLOGISTS IN CONTRAST MEDIUM STUDIES OF THE GASTROINTESTINAL TRACT. Perttala, Y.; Rinne, R.; Rytilae, A. (Univ. Central Hospital, Helsinki). Ann. Med. Internae Fenn., 55: 61-3(1966).

The radiation doses to the examining physician were measured by radiophotoluminescence dosimetry during 100 contrast medium studies of the gastrointestinal tract. The measurements were taken at 7 different sites on the body. The doses received by two radiologists (wearing 0.25 mm Pb-equivalent lead rubber aprons and gloves) on these sites were as follows: forehead 6, 1.5 mR/50 examinations; chest (under apron) 0, 0; right forearm 78, 112; right forefinger (under glove) 24, 270; left forearm 120, 93; right inguinal fold (under apron) 3, 64; and right leg 56, 8. The radiologists received less than maximum permissible doses. The results show that the highest doses were received by the forearm. Means whereby doses can be reduced during fluoroscopy are discussed. Television fluoroscopy should be employed in lieu of ordinary fluoroscopy as the radiation doses in this technique are considerably smaller. In some special examinations, e.g., angiography, cardioangiography, and urethrocystography, it is difficult for the roentgenologist to avoid secondary radiation to the arms. If the apparatus is in good condition, correct methods are employed, and caution is observed, the doses are generally small. However, to achieve a satisfactory examination the roentgenologist is often subjected to greater doses in practice, e.g., because of the patient's poor condition or special examinations. (BBB)

10891 TECHNIC AND INDICATION FOR RADIOTHERAPY WITH SEALED BETA IRRADIATORS. Schlungbaum, W. (Staedtische Krankenhaus, Berlin-Spandau, Ger.). Roentgenpraxis, 18: 201-8(Sept. 1965). (In German).

Dose fall-off for various ^{90}Y sealed β irradiation sources is reviewed. Other sources of β radiation are discussed, including ^{131}I, ^{198}Au, ^{32}P, and $^{90}Sr-^{90}Y$. The details of treatment for these various pathological conditions are presented, with descriptions of the applicators and methods available. Dose levels at the surface of the applicators are illustrated, and tissue isodose curves are plotted. (TSS)

10892 RADIOISOTOPE FACILITIES IN THE GENERAL HOSPITAL. Ingraham II, Samuel C.; Barnett, Mark; Taylor, Wilbur R. (Public Health Service, Washington, D. C.). Public Health Service Publ., No. 930-D-22, 8p(Jan. 1966).

A survey was made of the medical uses of radioisotopes, hazards associated with their use, radioprotection practices in medical labs, and suggested plans for such labs. Basic guidelines are provided for the planning of radioisotope facilities in the general hospital, in new or in already existing buildings. Factors that will influence location of the department are discussed. The location of inpatients who have received radioisotopes is also considered. The staffing of a radioisotope facility is discussed on the basis of the workload and the variety of procedures undertaken. A description of the general kinds of activities performed in the radioisotope department provides some information of the space and equipment required. Two plans for hospital radioisotope departments are shown, and importance of various types of equipment is discussed. Two suggested plans show the relation between the workload and facilities required. (TSS)

10893 CALCULATION OF TOTAL ISODOSE CHARTS IN MULTIFIELD IRRADIATION ON AN ELECTRONIC COMPUTING MACHINE M-2. Kvasov, V. A.; Astrakhan, B. V. Med. Radiol., 11: No. 10, 14-19(Oct. 1966). (In Russian).

The technique of using an electronic computing machine (M-2) for the automation of calculations of the total isodose charts in multifield irradiation is described. The most rational methods of storage and treatment of dosimetric information are discussed. (C.H.)

10894 RADIATION PROTECTION IN CEREBRAL DIAGNOSIS WITH ^{131}I-LABELED HUMAN SERUM ALBUMIN. Morczek, A.; Abraham, K.; Koch, R. D. (Medizinische Akademie, Magdeburg, Ger.). Radiol. Diagn., 7: 301-5(1966). (In German).

Experimental investigations concerning the problems of radiation protection in cerebral diagnosis with ^{131}I-labeled human serum albumin yielded the following results: no extra precautions are necessary in keeping a patient after γ-encephalography in the clinic; for the personnel in the wards and rooms where the investigation is conducted, no special radiation protection measures are required; the contamination risk from a brain operation after γ-encephalography can be ignored if the period between the injection of RISA (5 μCi/kg body weight) and the operation is longer than 9 days; and the whole-body dose received by the patient during γ encephalography usually does not exceed 800 Mrad. (auth)

10895 HEALTH STATUS EVALUATION OF PERSONS DEALING WITH RADIOACTIVE ISOTOPES IN SCIENTIFIC AND RESEARCH INSTITUTIONS. Gorbarenko, N. I. Med. Radiol., 11: No. 12, 25-32(Dec. 1966). (In Russian).

For over a period of 10 years 893 workers dealing with and exposed to radioisotopes were kept under outpatient observation, and 70 were examined under hospital conditions. The state of health in persons examined was satisfactory. A certain quickening of regulatory reactions, along with shifts in the peripheral blood, in the form of a moderate leukopenia, lymphocytosis, reticulocytosis, and individual cases of the clinical syndrome typical of chronic radiation sickness were disclosed in persons in whom total and single radiation doses surpassed the maximum permissible one. The shifts were but slightly pronounced, lay within the variation range of physiological fluctuations, showed no progressive evolution, and were observed to occur during the first 3 to 5 and 6 to 8 years of work in conditions involving irradiation exceeding the levels now regarded as maximum permissible ones. (auth)

10896 PROBLEM OF THE OPTIMAL DOSE IN THE IRRADIATION OF HODGKIN'S DISEASE. Papillon, J.; Chassard, J. L.; Contamin, A. (Centre Leon Berard, Lyon). Nouv. Rev. Franc. Hematol., 6: 161-3(Jan.-Feb. 1966). (In French).

Considerations are given to determining treatment plans and dosages which will give long-term survival in Hodgkin's disease, with a high degree of malignant cell sterilization, while preventing injury to normal tissues. Often, swollen lymph nodes will respond dramatically to doses below 2000 rad, whereas some cervical and mediastinal adenopathies will not respond to a dose of 4000 rad given in 4 weeks. Two cases which were irradiated showed unimpeded mediastinal adenopathy after 3500- and 4000-rad doses (1000 rad per week). With modern high-energy radiation sources, providing more homogeneous distribution of the dose than possible formerly, the authors recommend minimum doses of 3500 rad, which sterilize lymph nodes in most cases. Additional doses of 1000 to 1500 rad may then be given, for total doses of 4500 to 5000 rad. These additional doses are required in 15 to 20% of the cases treated. (BBB)

10897 DOSIMETRIC SUBSTANTIATION OF THE PROCEDURE INVOLVING BI-AXIAL PENDULUM X-RAY THERAPY IN MALIGNANT TUMORS OF THE UTERUS. Frolova, A. V.; Shulgina, Z. I.; Kachorovskaya, I. B.; Lazurkina, V. D.; Ustinskov, V. I. Med. Radiol., 11: No. 12, 3-7(Dec. 1966). (In Russian).

A procedure involving x-ray treatment of the true pelvic cavity is described and dosage field distribution under certain conditions of irradiation defined. Relations governing ratios of the skin to focus doses in pendulum irradiation are derived. (auth)

10898 CALCULATION OF THE TOTAL DOSE OF THERAPEUTIC IRRADIATION DELIVERED TO THE THYROID GLAND BY RADIOIODINE ^{131}I. Peyrin, J. O.; Berger, M. Rev. Lyon Med., 15: 27-62(Jan. 15, 1966). (In French).

Various parameters which influence the optimal dose of ^{131}I for treatment of hyperthyroidism are evaluated and formulas are derived for calculation of the dose. Means are presented for estimating these parameters, and examples of use of the formula are given. Use of the thyroid scintiscan to estimate volume and mass of the gland is illustrated. In toxic adenoma, a correction can be introduced in estimation of the mass. (TSS)

10899 THERMOLUMINESCENT DOSIMETRY OF INTERNAL ORGANS USING ^{90}Sr INCORPORATION. Steinbach, Karl Heinz; Kriegel, Heinz (Heiligenberg-Institut, Ger.). Strahlentherapie, 131: 473-9(Nov. 1966). (In German).

An instrument used for evaluating thermoluminescent dosimetry has been described. The standard deviations of the reproducibility and of the dose proportionality were less than ±4%. $^{90}Sr-^{90}Y$ was injected intravenously into white rats and the dose of the β-radiation was measured as a function of the incorporation time. The dose rate, a function of the incorporation time, was obtained by the first derivative of the dose curve versus time. By means of a graphical analysis, the dose rate could be divided into two parts with different decay times. The portion with a half life time of 1.4 days was accredited to the $^{90}Sr-^{90}Y$ activity of the abdominal organs in the immediate neighborhood of the dose meter. The slower decaying portion with a half life time of 10 days was re-

lated to the fast exchanging skeleton fraction of $^{90}Sr-^{90}Y$. Manganous activated calcium fluoride and TLD 100 were used as phosphor substances. (auth)

10900 SOME EXAMPLES OF THE APPLICATION OF THE LOGNORMAL DISTRIBUTION IN RADIATION PROTECTION. Gale, H. J. (Atomic Energy Research Establishment, Harwell, Eng.). Ann. Occup. Hyg., 10: 39-45(Jan. 1967).

The properties of the simple lognormal distribution are briefly described, and illustrated with examples from the field of radiation protection. Consideration of the use of the distribution is recommended for experimental data which are asymmetrically distributed. (UK)

10901 STUDIES ON PROTECTIVE EFFECTS OF MERCAPTOPYRIDOXINE AND 5-HYDROXYTRYPTAMINE AGAINST MUSTARD GAS. Schunk, Josef (Bundesamt fuer zivilen Bevoelkerungsschutz, Bad Godesberg, Ger.). Strahlentherapie, 131: 445-8 (Nov. 1966). (In German).

Not only the cysteine-cysteamine group protects against ionizing radiation and nitrogen mustard as well, but also cyclic compounds with a free SH-group, such as the mercaptopyridoxine, a derivative of vitamin B_6. On the contrary, 5-hydroxytryptamine (serotonin), which exerts a great radioprotective effect, does not exhibit a protection against nitrogen mustard. Even under the assumption that ionizing radiation and nitrogen mustard have the same effect on the nucleic acid synthesis, different action mechanisms must occur. (auth)

10902 STUDIES ON BIOLOGICAL RADIATION PROTECTION. REPORT 75. STUDIES ON THE INFLUENCE OF CYSTEINE AND METHIONINE ON FORMATION OF FREE RADICALS IN FREEZE-DRIED RAT LIVER. Moenig, Hans; Koch, Ruprecht (Univ., Freiburg i. B.). Strahlentherapie, 131: 408-14(Nov. 1966). (In German).

Freeze-dried rat liver, which was x-irradiated in vacuum, exhibited an ESR-spectrum which consisted of two components. Addition of air changed the radical configuration; it is assumed that a carbon-radical is changed into an alkoxy-radical. Liver treated with cysteine solution prior to freeze-drying exhibited, in vacuum, the same x-ray-induced radical configuration as non-treated liver. After addition of air an additional new signal was observed at $g = 2.016$, which is attributed to a sulfur-ion located at a mixed disulfide. Mechanical mixtures of cysteine and freeze-dried liver as well as liver treated with methionine prior to freeze-drying did not show the signal in the region of the lower magnetic field strength. (auth)

10903 STUDY OF CERTAIN PHARMACODYNAMIC PROPERTIES OF CYSTAMINE AND CYSTEAMINE IN DIVERSE ANIMAL SPECIES. Beaumariage, Marie-Louise; van Canegheim, Pierre; Bacq, Zenon Marcel (Univ., Liege). Strahlentherapie, 131: 342-51(Nov. 1966). (In French).

Intravenous or intraperitoneal injection of cysteamine or of cystamine induces in the cat, rabbit, and chicken complex blood pressure changes, the most frequent being hypotension followed by homeostatic reactions against it. The actions of small doses of cysteamine (but not of cystamine) may be reversed by atropine. The contraction of the nictitating membrane in the cat happens during the recuperation of the blood pressure, i.e., during the phase of adrenergic homeostatic reaction. In our experiments cystamine does not seem to liberate histamine as shown not only by blood pressure experiments but also by permeability tests and titration of endogenous histamine in the skin. Reduction by methysergide of the edema following cystamine injection and decrease of 5-hydroxytryptamine content of the skin show that 5-hydroxytryptamine plays a role in the vascular reactions induced by this radioprotective disulfide. (auth)

10904 THE RELATIVE TOXICITIES OF ^{226}Ra, ^{239}Pu, AND ^{90}Sr FOR BONE TUMOR INDUCTION. Hems, G.; Mole, R. H. (Radiological Protection Service, Sutton, Eng. MRC Radiobiological Research Unit, Harwell, Eng.). Brit. J. Radiol., 39: 719-26(Oct. 1966).

The considerations that have determined the max permissible body burdens of ^{239}Pu and of ^{90}Sr during the past two decades have gradually changed. At first they were based on experimental comparisons of toxicity using ^{226}Ra as a baseline. More recently max permissible body burdens were derived from the calculated dose to the skeleton, with ^{226}Ra as a baseline but with the inclusion of a non-uniformity or relative damage factor. The most recent experimental evidence on the induction of bone tumors in the mouse and beagle suggests that the toxicity of ^{226}Ra for the induction of bone tumors is 60 to 200 times the toxicity of ^{90}Sr, a larger ratio than was hitherto believed. An increase of the max permissible body burden of ^{90}Sr would be compatible with present experimental data on the toxicity of ^{90}Sr. In the beagle the toxicity of ^{239}Pu relative to ^{226}Ra is in reasonable agreement with their present max permissible body burdens. (auth)

10905 STANDARD MAN IN RELATION TO INTERNAL RADIATION DOSE CONCEPTS. Snyder, Walter S. (Oak Ridge National Lab., Tenn.). Amer. Ind. Hyg. Ass. J., 27: 539-45(Nov.-Dec. 1966).

The extension of the Standard Man concept, insofar as radiation protection is concerned, is considered to provide a basis for estimation of dose when exposure of a population is in question. Discussion is organized around three main considerations: data of a physical and chemical nature concerning the principal organs and tissues; data of metabolic nature concerning bodily intake and excretions; and ranges of individual variation that are not uncommon and means of allowing for these differences. (auth)

10906 MEASURING URETERAL RADIATION DOSES. Unnerus, C.-E.; Widholm, O.; Kiviniitty, K. Ann. Radiol., 9: R741-7(1966).

A dosimeter that can be inserted into the ureter on the tip of a catheter is described. Precision placement of the device is accomplished by means of radiography. Measurements of dose using the glass dosimeter varied less than 20% from those derived by isodose curves. (H.G.D.)

10907 ACTIVE BONE MARROW DISTRIBUTION IN THE ADULT. Russell, Walter J.; Yoshinaga, Haruma; Antoku, Shigetoshi; Mizuno, Masayoshi (Atomic Bomb Casualty Commission, Hiroshima. Hiroshima Univ.). Brit. J. Radiol., 39: 735-9(Oct. 1966). (TID-23310).

A study of active bone marrow distribution was made, and tables were compiled showing percentage and quantity of active marrow at specific locations. They will facilitate dose calculations for standard diagnostic and therapeutic radiological procedures, and are adaptable for possible use with an electronic computer. (auth)

10908 PHOTOGRAPHIC METHOD OF ISODOSE CALCULATION FOR TELEGAMMATHERAPY. Stankevich, A. A.; Pakulina, L. E. (Inst. of Oncology, Leningrad). Vop. Onkol., 12: 93-7 (1966). (In Russian).

A photographic technique for isodose calculation in γ-teletherapy is presented that is simple and rapid. Use of the method in radiological clinics is discussed. (H.G.D.)

10909 EXTENSIVE IRRADIATIONS IN HODGKIN'S DISEASE: EARLY REACTIONS. Tubiana, M.; Rambert, P.; Laugier, A.; Lalanne, C. M. (Institut Gustave-Roussy, Villejuif, France). Nouv. Rev. Franc. Hematol., 6: 164-74(Jan.-Feb. 1966). (In French).

Problems of determining the optimal dose and technique in radiotherapy for Hodgkin's disease are examined with particular attention to preventing side effects, especially bone marrow depression. Forty-one cases were given ^{60}Co treatment to total doses of 3500 to 4000 RAD extending over 20 months. The average abdominal dose was 330 RAD at each session. Alternating anterior and posterior fields were used. For a planned dose of 4000 RAD the estimated dose at a 2-cm depth was 3800 RAD and at 7 cm, 3900 RAD. The good tolerance of the patients to these doses was attributed to the fact that the spleen was not irradiated (contrary to other authors' recommendations) and the youth of the subjects, wherein humeral and femoral marrow sites were of major importance. Radiation was interrupted when platelet counts fell below 50,000 and polynuclear leukocytes below 1000 per mm^3. Doses in various areas which cause marrow aplasia are given. A dose of 3500 RAD over 4 weeks sterilized local lesions. Only in one case did irradiation, accompanied by severe aplasia and icterus, cause a fatality. (BBB)

10910 DETERMINATION OF THE INTEGRAL DOSE ABSORBED BY A PATIENT TREATED WITH TELECOBALT THERAPY BY THE ORBITRON OF THE CENTRO DE ONCOLOGIA Y MEDICINA NUCLEAR OF THE HOSPITAL DE SAN JUAN DE DIOS IN MADRID, BASED ON A STUDY OF THE RADIATION BEAM. Olivares Munoz, M. P. (Hospital de San Juan de Dios, Madrid). Acta Oncol. (Madrid), 3: 244-50(July-Dec. 1964). (In Spanish).

Reasons for and methods of determining the absorbed dose are explained, and theoretical aspects of dose absorption by tissue are considered. The concept of the integral absorbed dose is based on the physical action of radiation in a given volume of irradiated material. Formulas are derived showing how this dose is calculated. It was shown that the log of the absorbed dose varied linearly with the skin area over the range 1×10^3 to 12×10^3 rad. This relation demonstrates that the absorbed dose increases considerably as the area irradiated increases (from 1000 rad at a 50-cm^2 area to 12,000 rad at a 400-cm^2 area, with the ^{60}Co source used). (BBB)

10911 DENTAL ROENTGENOLOGY IN THE OBSTETRIC PATIENT. Warheit, Allen. Clin. Obstet. Gynecol., 9: 71-4(Mar. 1966).

The question of the safety of dental x-ray examinations in

pregnant patients is considered, and means whereby the possible hazards to the fetus can be reduced are stated. If there is any suspicion of early gestation, a delay in the performance of full-mouth radiographic exploration would be justified until the end of the third month of pregnancy when most organogenesis has been completed. The affected tooth, however, should be studied by x ray if necessary. The beam should be directed away from the region of the gonads by proper tilting of the patient's head. Only emergency dental therapy is indicated in the first trimester. The hazard of stress-induced abortions falls rapidly after the twelfth week of pregnancy. With an x-ray tube operating at 70 kvp, with electronic timers, lead aprons or shields, a collimating device to limit the beam to 2.75 in. and aluminum filtration of 2.25 mm, the radiation hazard to the pregnant but otherwise healthy woman and to her fetus can be eliminated. (BBB)

10912 SOME CONSIDERATIONS OF RADIOLOGIC PROTECTION. Sedlak, Marie Patrice. Radiol. Technol., 35: 176-9(Nov. 1963).

Ways of protecting patients and personnel from unnecessary or excessive doses of radiation in diagnostic radiology are outlined. Prior to roentgenographic examination of any patient, information should be obtained regarding previous irradiation and the date it was received by the patient. Patients may have been examined elsewhere and may already have received radiation exposure that would limit further roentgen examination or treatment. It is important also to check for accuracy of technique, especially as it regards the proper inclusion of filters. An electrical timer, in the x-ray circuit of the fluoroscopic unit, is also a means of protection for the patient, particularly in fracture reductions under fluoroscopy. A filter should be used to block the soft x rays while permitting unimpeded passage of the hard rays; filtration results in an improved roentgenogram and protection for the patient. Another method useful in protecting the patient and increasing film quality is to limit the x-ray beam, to the precise area of medical interest, by coning. The operator should take a position as far removed as possible and behind a protective wall or control booth. He should always avoid exposure to the direct beam emerging from the x-ray tube, and remember that the effects of x rays are increased or decreased in proportion to the square of the distance. If the technician must hold a film or assist a patient during an exposure, he should take a position that is not in direct line with the tube. In addition to this, protective lead gloves and aprons should be worn. In fluoroscopy the technician should wear a lead rubber apron of 0.5 mm lead equivalent. In addition to the use of a film badge, x-ray technicians should have periodic blood tests no less than every six months. (BBB)

10913 METHOD FOR PROTON IRRADIATION OF RATS. England, L. D. (Texas Nuclear Corp., Austin). Nature, 212: 1596-7(Dec. 31, 1966).

An effective, relatively inexpensive method for the irradiation of small animals with protons is described that makes use of a 3.2 MeV positive ion accelerator to provide 13 MeV proton fluxes of up to 10^7 protons/cm^2/min in conjunction with a ferris wheel-type animal holder that rotates about the end of the accelerator drift tube in which the protons are produced. Using this system, rats were given proton surface doses ranging from 100 to 2,500 rads. The protons were monitored directly with a CsI scintillation detector mounted just outside the periphery of the ferris wheel. The detector was optically coupled to a photomultiplier tube, the output of which was fed into a linear amplifier and discriminator, and the output fed into a multichannel pulse height analyzer or into a scaler. Details of the dosimetry are included. The method gave good results for a variety of small animal studies with protons. (C.H.)

10914 THE EVALUATION OF RISKS FROM RADIATION. A Report Prepared for Committee I of the International Commission on Radiological Protection and Received by the Committee on April 20th, 1965. ICRP Publication 8. New York, Pergamon Press, 1966. 65p. 12s. 6d.; $2.00.

Increased incidence of leukemia is the major consequence of exposure of a large part of the body to radiation. There is no clear evidence that radiation in small doses will give rise to serious consequences other than cancer. Quantitative estimates of risk have, therefore, been attempted only for the induction of cancer. Risks of cancer induction by radiation are estimated. The figures refer to the annual risk under continuous exposure to 1 rad per year or to the lifetime risk from a single exposure to 1 rad. The estimates are based mainly on observations of survivors of atomic bombing. Figures are given for the estimated genetic detriment to the first generation of a million offspring in a population where the whole parental generation had received 1 rad and 30 rads in addition to natural background radiation. From the data available, the total number of genetic effects expected over many generations will considerably exceed the somatic injuries sustained by the exposed generation. A comparison of risks from radiation with other risks was undertaken. The annual risk of death from leukemia and other causes is shown by a graph. The additional risk of leukemia which would be expected from continuous exposure to 1 rad per year throughout a working life is also shown; this estimate is based on the assumption that the risk of leukemia is linearly related to the radiation dose. Statistics regarding occupational risks show that risk of death from radiation is less than that from industrial occupations. The orders of risk for somatic injury to which members of the population may be currently subject from radiation are noted. For natural background radiation the limit for the great bulk of the world's population is of the sixth order. For those directly engaged in radiation work, the risk is of the fifth order since the annual exposure is on average about 0.5 rad per year. (H.L.W.)

Medicine

Refer also to abstracts 10348, 10744, 10890–10892, 10896, 10907–10910, 11003, 11015, 11043, 11044, 11048, 11056, 11057, 11063, 11065, 11066, 11078, 11088, 11089, 11093, 11099, 11105, and 11108.

10915 (BNL–10893) COMPUTER APPLICATIONS IN A NUCLEAR MEDICINE RESEARCH PROGRAM. Robertson, James S. (Brookhaven National Lab., Upton, N. Y.). [1966]. Contract AT(30-2)-Gen-16. 23p. (CONF-661034-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Conference on the Use of Computers in Radiology, Chicago, Ill.

Typical problems that arise in a nuclear medicine program and that require, or at least are greatly assisted by, computer methods are outlined. Most of these could be programmed for small computers, but some require large installations. (auth)

10916 (COO–245–6) THE DESIGN, TESTING, AND INSTALLATION OF A NEW ^{137}Cs TELETHERAPY DEVICE. Simons, Charles S.; Lampe, Isadore (Michigan Univ., Ann Arbor. Alice Crocker Lloyd Radiation Therapy Center. Michigan Univ., Ann Arbor. Medical Center). July 1965. Contract AT(11-1)-245. 63p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The application of a new method for room shielding computation has resulted in the modification of an existing deep therapy room with a minimum of expenditure of additional lead. A simple, but novel, device was designed to protect the door crack from radiation. The resulting teletherapy room radiation protection reduces the anticipated exposure to the order of 20 mR per week for both radiological and non-controlled personnel. The radiation surveys of the teletherapy head indicates that the relocation of some of the lead used only for counter-balancing to regions around the lower part of the head produced a marked reduction in "ON" leakage with no increase in the weight of the unit. The recent measurements of the half-value layer agrees with the measurements made initially. This confirmation can be used to rule out any likelihood of prior contamination of the cesium-137 source with the 2.7 year half-life cesium-134, since the gamma rays of the latter nuclide are much more energetic and would have caused an obvious reduction in half-value layer as the contaminant decayed by a factor of about 10. (TSS)

10917 (EUR–3129.f,i) NUCLEAR MEDICINE. Annual Report, 1965. (Brussels Univ. (Belgium). Pisa Univ. (Italy)). Aug. 11, 1966. 124p. (In French and Italian). Dep. mn.

Applications of nuclear techniques to medical diagnosis and therapy at Brussels and Pisa during 1965 are summarized. Nuclear techniques were used for: development of analog and digital methods for the deconvolution and adaptation of curves for dynamic analysis of metabolism; measurement of local blood flow and detection of cardiac shunts; studies on erythrocytopoiesis and erythropoietin; tumor diagnosis by external counting; diagnosis and pathogenesis of dehydration states in children; diagnosis of thyroid diseases; treatment and prophylaxis of endemic goiter and cretinism; measurement of adrenal secretion; measurements of protein, fat, and carbohydrate metabolism; and determination of mitotic-cycle parameters. (H.G.D.)

10918 (CONF-660412–6) LEGAL PROBLEMS CONNECTED WITH A NUCLEAR ACCIDENT. Jacchia, E. Translated by R. A. Slingo (Atomic Energy Research Establishment, Harwell, Eng.), from Paper Presented at the Symposium on Accidental Irradiation at Place of Work, Nice, France, April 25–29, 1966. 22p. DTIE.

Problems involved with social insurance for nuclear accidents are discussed. Particular reference is made to: the difficulty of establishing causality in certain types of injuries; estimation of injuries suffered; compensation for injury and time limits for claims; differentiation between industrial injuries and industrial

diseases; and the classification of radiation injuries as industrial injuries. (H.G.D.)

10919 (NP-tr-1490) LOCATION OF A PARATHYROID ADENOMA ONLY AFTER SCINTIGRAPHY WITH ^{75}Se-METHIONINE. Bartelheimer, H.; Fritzsche, H.; Kuhlencordt, F.; Schneider, C.; Zukschwerdt, L. Translated by W. K. Dunscombe (Atomic Energy Research Establishment, Harwell, Eng.), from Klin. Wochensch., 43: 854-6(1965). 9p. Dep. mn. JCL $1.10 fs, $0.80 mf.

Five unsuccessful operations were performed on a 22 year old woman with primary hyperparathyroidism. A successful diagnosis was made by the use of scintigraphy with ^{75}Se-methionine. The patient was given a low calcium diet and treated with triiodothyronine daily for 10 days to reduce protein synthesis in the thyroid; then received ^{75}Se-labeled methionine intravenously. A photoscan revealed a notable increase of activity to the left of the larynx; this was the site of the parathyroid adenoma which was removed by surgery. The possibilities and limits of this diagnostic procedure are discussed. (H.L.W.)

10920 (NP-tr-1492) TREATMENT OF BLADDER TUMOURS WITH A RADIOACTIVE NITROGEN MUSTARD. Georgacopulo, P.; Stancanelli, V.; (and others). Translated by O. S. Whitston (Atomic Energy Research Establishment, Harwell, Eng.), from Minerva Med., 56: 1476-8(1965). 7p. Dep. mn. JCL $1.10 fs, $0.80 mf.

Sulfur-35-labeled triethylene thiophosphoramide was introduced into the bladder of three patients 30 min prior to surgical removal of vesical papillomas. Histoautoradiographic studies revealed that the radioactive nitrogen mustard was diffused throughout the neoplastic tissues, both endothelial and connective. Reabsorption of the compound by the epithelium was quantitatively inhomogeneous but always constant and massive. It is concluded that application of radioactive nitrogen mustard may be useful in treating inoperable malignant growths of the bladder. (H.G.D.)

10921 DISTRIBUTION OF 5-HYDROXYTRYPTAMINE-2-^{14}C IN MICE WITH RESPECT TO CHEMICAL PROTECTION AGAINST IONIZING RADIATION. Streffer, Christian (Univ., Freiburg i. B.). Int. J. Radiat. Biol., 11: 305-6(1966).

An attempt was made to elucidate the mechanism of the radioprotective effect of 5-hydroxytryptamine. Mice were injected intraperitoneally with 5-hydroxytryptamine-2-^{14}C (1 μC per animal) and the radioactivity was measured for 5–40 min in different organs. About 85% of the radioactivity was found in the small intestine, kidney, liver, and spleen. The brain contained very little radioactivity. Whole-body x-irradiation (750 R) did not increase the brain radioactivity. (TSS)

10922 STUDIES ON "SECONDARY DISEASE" IN SYNGENEIC MOUSE RADIATION CHIMAERAS. Sljivic, Vojin S. (Medical Research Council, Harwell, Eng.). Int. J. Radiat. Biol., 11: 273-86(1966).

Lethally irradiated CBA mice restored with syngeneic foetal liver cells developed "secondary disease" during the second month after irradiation. This could be prevented by an additional treatment with syngeneic lymph-node cells. At various times through the course of 3 months cellularity of lymphoid tissues, immunological responsiveness, phagocytic activity of the RES and liver function were studied. The results have shown that mice restored with foetal liver cells, when compared with animals restored with foetal liver plus lymph-node cells, had a smaller number of cells in their lymph nodes and poorer immunological responsiveness during the first 2 or 3 weeks after irradiation. At 4 weeks, i.e., just before the appearance of "secondary disease," the phagocytic activity of the RES was increased. At the time when "secondary disease" was clinically fully developed the two experimental groups were hardly different between themselves or with respect to unirradiated controls, except for the thymus which was reduced in weight and cellularity in the mice not given lymph-node cells. It is suggested that "secondary disease" in syngeneic foetal liver chimaeras is caused by a protracted infection which begins during the early post-irradiation period. (auth)

10923 PREVENTION OF THE BONE-MARROW SYNDROME IN IRRADIATED MICE. A COMPARISON OF THE RESULTS AFTER BONE-MARROW SHIELDING AND BONE-MARROW INOCULATION. de Vries, F. A. J.; Vos, O. (Medical Biological Lab., TNO, Rijswijk, Netherlands). Int. J. Radiat. Biol., 11: 235-43(1966).

Shielding of bone marrow in x irradiated mice was compared with intravenous injection of a bone marrow cell suspension in its effectiveness to prevent a bone marrow syndrome. Three criteria were used to measure this effectiveness: survival of the irradiated mouse at 30 days after irradiation, re-population of irradiated haematopoietic tissues, and incidence of spleen colonies. On the basis of the number of cells involved bone marrow injection appeared to be about 100 times more effective than bone marrow shielding. (auth)

10924 DNA AND PROTEIN METABOLISM IN RADIOPROTECTED RATS AFTER LETHAL IRRADIATION. Dimitrov, L. (Higher Inst. of Medicine, Sofia). Int. J. Radiat. Biol., 11: 229-33(1966).

A lethal whole-body irradiation (800 R) of albino rats inhibits the individual elements of the synthesis of DNA and protein. Radioprotectors (serotonin, AET, MEA) and their combination with therapeutic agents (bone-marrow, antibiotics, vitamins) protect the animals from disturbances in the DNA and protein metabolism in the early period and partly in the later period after lethal irradiation. The average life expectancy of irradiated radioprotected rats is shorter compared with that of non-irradiated animals. (auth)

10925 NEW COLLOIDAL CHROMIC RADIOPHOSPHATE (^{32}P) FOR LOCAL IRRADIATION OF THE CENTRAL NERVOUS SYSTEM. Anghileri, L. J.; Marques, R. (Comision Nacional de Energia Atomica, Buenos Aires). Int. J. Appl. Radiat. Isotop., 18: 97-100(1967).

A method for the preparation of a true colloidal solution of chromic radiophosphate is given. The measurement of the isotopic exchange with inactive ionic phosphate indicates good stability. A study of the body distribution in rabbits after cisternal injection shows that approximately 80% of the administered colloid remains in the spinal cord and the rest diffuses into the organism, being incorporated mainly into liver and bone. Physiological assay in rabbits indicates that this colloid induces only a slight neuroirritation, compared with the more critical effects observed with larger size particle phosphate colloids. This colloid provides a new potential tool for the irradiation in situ of the central nervous system, which has advantages over the classic teletherapy. (auth)

10926 RADIOSENSITISERS. Lancet, 1: 1398-9 (June 18, 1966).

Possible means by which radiosensitivity of tumor cells can be increased are surveyed. The most effective method of rendering cells more sensitive to radiation is by use of analogs of the purines and pyrimidines that make up nucleic acids. Biologically active analogs are incorporated into the DNA of the cell in place of a normal base, the most widely used being bromodeoxyuridine (BUDR) which replaces thymidine in DNA. All cells containing BUDR in their DNA are more sensitive to radiation, whether oxygen is present or not, but this method of sensitization has little to offer in increasing differentials in radiation response. Nevertheless in mouse lymphoma cells, which varied rather widely in their initial radiosensitivity, BUDR had a much greater effect on the radioresistant than on the radiosensitive cell lines. Studies have demonstrated that the radiation response of cells can be influenced at the repair level, and therefore that selective modification is possible because cells vary in their capacity for repair. Sublethal radioinjury of cells is also considered. Its existence is revealed when the radiation is given in fractions. There may be clinical situations where interference with repair of sublethal damage is of value in a suitably timed course of radiotherapy, and a search for agents which might do this is now being conducted. (TSS)

10927 CELLULAR RECOVERY IN HYPERBARIC OXYGEN RADIATION THERAPY. Rossi, Harald H.; Biavati, Bruce J. (Columbia Univ., New York). Radiology, 87: 954-6(Nov. 1966).

The use of high-pressure oxygen to increase the radiosensitivity of malignant cells during radiotherapy is discussed. The question as to whether single or fractionated radiation doses are more effective in the case of oxygen-sensitized cells is considered. A mathematical model is presented for use in calculating cellular recovery in irradiated oxygen-sensitized cells. Calculations, based on the model, indicate that increasing the number of radiation dose fractionations will improve therapeutic results. It is pointed out that the model does not provide numerical answers, but merely indicates general trends, and that some of the assumptions used, particularly the assumption that both normal and malignant cells have equal sensitivity that does not change throughout therapy, may seriously affect the validity of the findings. (C.H.)

10928 COMPARATIVE RADIOPROTECTIVE EFFECTIVENESS OF COMPRESSED GASES. Paribok, V. P.; Kalney, V. S. (Inst. of Cytology, Leningrad). Nature, 211: 1428-9(Sept. 24, 1966).

Bean seedlings (Vicia faba) were irradiated and placed in chambers containing nitrogen, argon, or helium. The gas was introduced into the chamber 10 min before irradiation and left in for 5 min afterwards. The average growth rate of the main root was taken as a measure of the degree of injury. Results

are shown in the form of graphs. It is concluded that the protection is caused by inhibition of the diffusion of oxygen in the extracellular gas spaces of the root. (H.L.W.)

10929 METHODS OF CONTROLLING THE SOMATIC RADIATION HAZARD. Franzen, J. (Johannes-Gutenberg-Univ., Mainz). Fortschr. Geb. Roentgenstr. Nuklearmed., 105: 893-9 (1966). (In German).

Investigations on the possibility of reducing somatic radiation hazards were continued for full-size chest radiography and fluorography of the chest. An account is given of the dose distribution within the bone marrow, the evaluation of the marrow distribution in the exposed volume, the wavelength dependence of the marrow dose, and the effect of focus-film distance on dose. (auth)

10930 RADIOPREVENTIVE EFFECT OF ASSOCIATED CHEMICAL RADIOPROTECTORS (CYSTEAMINE, SEROTONIN, AET, AND GLUTATHIONE) AGAINST ACUTE RADIATION SICKNESS CAUSED BY A WHOLE-BODY LETHAL X RADIATION DOSE. Arghittu, C.; De Renzi, G.; De Pascalis, V.; Bragazzi, G.; D'Ambra, L. (Centro Applicazioni Militari Energia Nucleare, Pisa, Italy). Minerva Med., 56: 3861-5(Nov. 14, 1965). (In Italian).

Female Wistar rats were injected with solutions containing cysteamine, serotonin, and AET(I); cysteamine, serotonin, and glutathione (II); and cysteamine, serotonin, AET, and glutathione (III), 30 min before exposure to a lethal whole-body dose of x radiation. Thirty days after the irradiation the survival was 80% in rats treated with (I). The survival was 50% in the rats treated with (II). The group treated with (III) had 80% survival. A comparative experiment in which the rats received only one of the radioprotectors before exposure to a LD 75/30 dose showed that AET gave a survival of 85%, much more efficient than the other three chemicals. (J.S.R.)

10931 ON THE PROBLEM OF DIFFERENCE IN THE RADIOPROTECTIVE MECHANISM OF BETAMERCAPTOETHYLAMINE AND MEXAMINE (COMPARATIVE INVESTIGATION ON BACTERIA AND WHITE MICE). Strelkov, R. B.; Kavtaradze, K. N. Radiobiologiya, 6: 768-9(1966). (In Russian).

The protective effects of the amine radioprotector mexamine in comparison with the sulfur-containing agent ρ-mercaptoethylene were investigated in vivo and in vitro. The studies were made on white mice and Escherichia coli-675. The mice were exposed to γ doses of 1050 R after receiving injections of one of the two drugs. The bacteria were exposed to doses of 80 kr. The survival was the parameter used to determine the radioprotective effects. The results showed that mexamine does not protect microorganisms from radiation, although it is efficient, as is MEA, in the protection of mice. MEA is an efficient radioprotective agent for both mice and microorganisms. (J.S.R.)

10932 RADIOPROTECTIVE ACTION OF BACTERITIC NUCLEIC ACIDS AND THEIR DERIVATIVES BY γ IRRADIATION OF EXPERIMENTAL ANIMALS. Tumanyan, M. A.; Sinilova, N. G.; Duplishcheva, A. P.; Ivanov, K. K. Radiobiologiya, 6: 712-17(1966). (In Russian).

High polymer DNA, obtained from different forms of intestinal typhoid bacteria, has clear protective properties during intravenous and intraperitoneal introduction of mice and rats 24 hrs after lethal irradiation with γ rays. The denaturation of DNA with heat and its decomposition to oligonucleotides and mononucleotides (DNA-ase, with weakly acid hydrolysis) does not decrease significantly the radioprotective effect. The hydrolysis of DNA by bases completely destroys its protective properties. High polymer and low polymer RNA from intestinal bacteria shows equivalent DNA protective effect for intraperitoneal injection and somewhat reduced protection for intravenous injection. (tr-auth)

10933 POSTIRRADIATIVE MODIFICATION OF RADIATION DAMAGE IN FROGS (R. RIDIBUNDA). Kuzin, A. M.; Minaev, P. F. (Inst. of Biological Physics, Moscow). Radiobiologiya, 6: 690-2(1966). (In Russian).

The possibility of modifying the radiation damage by withdrawal of the radiotoxins from the animal organism was investigated on frogs (Rana ridibunda). The animals were divided into five groups—Group I was not exposed to any influences; Group 2 was not irradiated but subjected to surgery and irrigation with solutions of urea (2%) and 1,6-fructose diphosphate (10%); Group 3 was irradiated at a dose of 1500 R, subjected to surgery, but had no irrigation; Group 4 was irradiated at 1500 R, subjected to surgery, and irrigated with 10% solutions of 1,6-fructose diphosphate; and Group 5 was irradiated with 1500 R, subjected to surgery, and irrigated with 2% urea solutions and 10% 1,6-fructose diphosphate solutions. The results are discussed and shown graphically. In group 3 all of the animals were dead by the 20th day after irradiation. 11 of the 15 animals in Group 4 died. In Group 5 only 2 of the 15 animals died, as was true for Group 2. No animals died in Group 1. (J.S.R.)

10934 RADIATION RESPONSE IN THE THERAPEUTIC AND PROGNOSTIC EVALUATION OF CARCINOMA OF THE CERVIX. de Palo, G. M.; Conte, D.; Fasolo, G. F. (Univ., Padua). Attual. Obtet. Ginecol., 11: 513-23(July-Aug. 1965). (In Italian).

The value of the use of the radiation response (RR) histologic diagnosis as a means of predicting radiosensitivity of cervical cancer is questioned, mainly on the basis of a profusion of reports on this problem. A clinical evaluation was also conducted. The RR prognostication depends on certain changes that appear in desquamated vaginal cells subsequent to initial doses of radiotherapy. A review of the conflicting earlier reported studies shows that, in the main, this concept is of doubtful significance. An evaluation in 72 patients with Stages I, II, or III cervical cancer likewise showed no significant difference in survival of patients showing a good RR from those showing a poor RR. In fact, in the Stage III cases, survival rate was higher in patients showing a poor RR. It is concluded that this concept does not offer a valid means of predicting radiocurability. (BBB)

10935 A NEW METHOD OF EXTRAPERITONEAL SURGICO-RADIOTHERAPY FOR INOPERABLE CERVICAL CANCER. Shinagawa, Shiuryo (Hirosaki Univ., Japan). Nippon Sanka Fujinka Gakkai Zasshi, 10: 152-60(July 1963). (In German).

A set of new procedures for treatment of inoperable cervical cancer is described. It consists of four steps. The first is intracavitary Ra treatment with ~7200 mg-hr, given over a period of 2 to 3 weeks. During this period external depth therapy with x ray or telecobalt is given. The third step in the procedure is removal of the extraperitoneal lymph nodes, usually 2 to 8 weeks after the Ra treatment. The best results are obtained if there is a lapse of 2 to 4 weeks between the end of the first step and the start of removal of the lymph nodes. If the period is much longer than this the external iliacal vein may become involved. The fourth step in the series of procedures described is extraperitoneal interstitial irradiation by insertion of Ra capsules contained in polyethylene tubes into the lateral pelvic walls. Each side receives 2 to 3 capsules containing 10 mg of Ra each. These are introduced by means of flexible polyethylene tubes. The method of insertion and placement to ensure maximum effect on the tumor is described in some detail, and precautions to avoid hemorrhage from the areas affected are indicated. The implants are permitted to remain for 3 to 5 days, resulting in exposure of 1500 to 2100 mg/hr to each side. The method of removal of the polyethylene tubes containing the Ra is described. Although the 5-yr cure rate cannot be calculated yet, the short-term cure rate (12 to 22 months) is 89%. (BBB)

10936 SPLEEN IRRADIATION AND IMMUNOLOGICAL RESPONSE OF PERIPHERAL LYMPHOCYTES IN CHRONIC LYMPHATIC LEUKEMIAS. Astaldi, G.; Airo, R.; Casta, G.; Duarte, N. (Ospedale Civile, Tortona, Italy). Blut, 13: 100-5(May 1966). (In German).

Immunological response of peripheral leukemic lymphocytes to phytohemagglutinin was studied in vitro after irradiation of spleen in four patients. Two patients received 80 R at a time at 2- or 3-day intervals, for a total of 400 and 480 R. Before the irradiation only 9 to 11% blasts were present, but afterward there were 68 to 78%. This indicated that in chronic lymphatic leukemia peripheral lymphocytes yield the same % of blasts in phytohemagglutinin cultures after irradiation as lymphocytes from peripheral blood of healthy persons. This ability to react with phytohemagglutinin is lost 4 to 6 weeks after irradiation. Irradiation of the ribs and sternum did not have a similar effect. In another patient who received a total of 500 R, given 100 R/dose 8 or 10 days apart, with a final dose of 100 R 15 days later, the development of blasts was slower and the percent was less. Only 45% blasts were found. This may have been due to the longer intervals between the single irradiations. The effect of spleen irradiation continuously decreased during the two-week interval between the fifth and sixth irradiation, but the final dose was still effective. The fourth patient received a single irradiation of 300 R. Only 30% blasts were found. Although the results found in the patients seemed to differ with the total dose of irradiation and the dose fractionation, it is also possible that the irradiations destroyed lymphocytes which would not have reacted with the agglutinin, but left others that could react. (BBB)

10937 ON TREATMENT OF LETHAL RADIATION INJURY WITH NICOTINIC ACID DERIVATIVES. 2. ON THE THERAPEUTIC EFFECT RANGE OF 7-[2-HYDROXY-3-(N-2-HYDROXYETHYL-N-METHYLAMINO)PROPYL]-1,3-DIMETHYLXANTHINE-PYRIDINE-3-CARBOXYLATE AFTER LETHAL WHOLE-BODY IRRADIATION OF WHITE MICE. Barth, Gunther; Graebner, Herbert; Kampmann, Helmut; Kern, Walter; Noeske, Klaus (Univ., Giessen, Ger.). Arzneim.-Forsch., 16: 841-7(July 1966). (In German).

The radioprotective effect of this compound (Complamin) was tested in 1337 female NMRI mice and in 100 heterozygous male mice. The mice were exposed to whole-body x-ray doses of 650 to 1050 R, the latter dose representing the $LD_{90/30}$ for this species. Injection of 1 mg Complamin intraperitoneally immediately after irradiation resulted in markedly improved survival rates. In the 735-R group Complamin gave a 52% 30-day survival rate, compared with 0% in controls. After doses of 850, 1000, and 1050 R, the 30-day survival rates in treated and control animals were: 92%, 0%; 52%, 0%; and 0%, 0%, respectively. In mice infected with Pseudomonas, which generally increases the severity of radiation sickness, Complamin also exerted a protective effect. The fibrinolytic activity of Complamin in irradiated mice was demonstrated, and it is suggested that the drug acts on the fibrin deposition and thrombosis which is induced by irradiation. In this way oxygen transport to the tissues is increased and cellular metabolism improved. (BBB)

10938 PERFORATION OF THE ESOPHAGUS BY COBALT PEARLS. Celestino, Roberto R.; Corte, Federico B.; Falcon, Osvaldo; Meeroff, Marcos. Prensa Med. Argent., 51: 739-41 (Sept. 18, 1964). (In Spanish).

A case history of a patient is described who developed radionecrosis and subsequent perforation of the esophagus following ^{60}Co interstitial therapy. The patient was treated for neoplastic mass at the lower end of the esophagus and in stomach by implantation of 15 pearls containing ^{60}Co. Treatment continued for 24 hr, but no dose data are presented. This resulted in improvement of the patient's general condition and reduction of the tumor mass. Six months postirradiation the patient experienced acute intense epigastric pain which persisted, and because of dysphagia and anorexia his general condition steadily worsened. Endoscopic examination revealed fibrotic stenosis of the terminal esophagus. While surgery was being considered, the patient underwent massive hematemesis and shock, from which he did not recover. Autopsy revealed extensive ulceration of the esophagus and erosion of the aortic wall. Microscopic examination showed typical changes of radionecrosis, with nuclear pyknosis and fibrosis predominating. The submucosa of the stomach and terminal esophagus was invaded by an adenocarcinoma. (BBB)

10939 INFLUENCE OF EXTERNAL FACTORS ON THE PRODUCTION OF CONGENITAL MALFORMATIONS. Tuchmann-Duplessis, H. (Faculte de Medecine, Paris). Arch. Biol. (Liege), 75: Suppl., 1099-1131(1965). (In French).

The action of ionizing radiations and other physical and chemical agents in inducing anomalies in mammalian embryos is reviewed. The chronology of teratogenesis is explained. From the time of fertilization up to implantation of the blastocyst, malformations are not induced, and death of the embryo results. During the segmentation phase, severe malformations can be induced. The human embryo is very sensitive to ionizing radiations, and most fetal anomalies which follow therapeutic irradiation during pregnancy involve the eye and the nervous system. Women irradiated during the early stage of gestation may bear children with microcephaly, hydrocephaly, microphthalmia, or anophthalmia. Thus, microcephaly was observed in some in utero irradiated offspring of Japanese atomic bombing survivors. Recent experimental research has revealed that the hazards of radiotherapy during pregnancy are greater than were previously assumed, as regards fetal malformations. As little as 5 R can induce fetal anomalies in rats, in contrast to the 100 to 200 R, which formerly was regarded as the threshold teratogenic dose. (BBB)

10940 BONE MARROW GRAFT. Mathe, G.; Amiel, J. L.; Schwarzenberg, L. (Hopital Paul-Brousse, Villejuif, France). Ann. Biol. Clin. (Paris), 23: 567-85(May-June 1965). (In French).

Applications of bone marrow transplantation in irradiated persons and associated problems are reviewed. Such transplants were used in 8 leukemic subjects given 200 to 400 rad of x rays or betatron radiation over the whole body. None survived. A second group consisted of 5 persons exposed to γ and neutron radiation during a reactor accident. Four subjects were believed to have received an LD_{75} and the fifth subject an LD_{50}. Transfusion of marrow was successful in restoration of myeloid function. Ten other leukemic subjects were deliberately exposed to a 800-rad dose of ^{60}Co γ radiation and then transfused with allogenic marrow. Tentative take of the graft was seen in three, but two died later of myeloid aplasia. The other seven developed the secondary syndrome, but one survived for 20 months. Possible ways of avoiding the secondary syndrome are discussed. One means is by the use of multiple donors. Results are reported of a man transfused with marrow cells from 6 donors; successful hematopoietic function was restored. The use of various tests to detect incompatibility of donor cells with the recipient tissues is outlined. (BBB)

10941 LATE RADIATION INJURY OF THE CENTRAL NERVOUS SYSTEM AND THEIR RELATIONS TO RADIATION INJURIES IN OTHER ORGANS. Dihlmann, Wolfgang (Landesversicherungsanstalt Rheinprovinz, Aachen). Med. Welt, 26: 1375-80(July 1, 1961). (In German).

Manifestations of late radiation injuries induced by inadequate or overtreatment with radiation are discussed. These may include excessive single doses, improper geometrical dosage configurations in crossfire therapy, and too many or too few fields with focal doses that are too low. Late radiation injuries in the central nervous system fall randomly into the morphological and pathogenetic late radiation injuries to which the human organism is usually subject. Factors that influence the appearance of injuries following irradiation of tumors of the central nervous system are reviewed. Among the most prominent indications of late radiation injuries of the central nervous system are lesions in the capillaries, arterioles, and venules in the white substance causing disturbances of permeability. It is not possible to ascertain whether these result from vascular injuries of the vessel endothelia by primary absorption of the ionizing radiation or secondarily from substances produced by the ionizing radiation in the region of the vessels. These reactions are not radiation specific. Because of the changes in protein constituents in tissue that follow radiation injury of the central nervous system, these are frequently designated as amyloid, paramyloid, hyalinoid, colloidal degeneration, fibrinoid regeneration or necrosis. (BBB)

10942 GENETIC IMPLICATIONS OF CLINICAL RADIATION OF WOMEN SUFFERING FROM STERILITY. Kaplan, Ira I. J. Nat. Med. Ass., 52: 13-16(Jan. 1960).

Possible genetic and somatic effects of therapeutic irradiation, for sterility, were sought in 800 women and their offspring. The irradiation employed was low-dosage, high-voltage filtered x rays. A mean tissue dose of 65 R was administered to the ovaries, and a mean tissue dose of 90 R was also administered to the pituitary. These treatments were spread over a 14-day period. Ages of the patients varied from 18 to 45. In general, the best response to irradiation was achieved in the 20 to 30 yr group. The older women, as a rule, failed to respond to irradiation. Of the 606 children born to irradiated mothers, 20 died at, or shortly after birth. Only three hydrocephalic and one acephalic case may be considered as possibly due to some genetic effect of radiation. All but four of the living children of the 327 irradiated mothers who responded to the survey are normal, physically, mentally, and scholastically. Four children were born with abnormalities, two with digital anomalies and two with mental retardation. There has been no cancer, leukemia, or Hodgkin's disease in any of the children, some of whom are now over 30 years of age, or in the women irradiated for sterility. It was also noted that in the 52 grandchildren so far born of these irradiated women, no case of neoplasia has occurred. (BBB)

10943 SARCOMATA OF THE OSTEOGENIC SERIES (OSTEOSARCOMA, FIBROSARCOMA, CHONDROSARCOMA, PAROSTEAL OSTEOGENIC SARCOMA, AND SARCOMATA ARISING IN ABNORMAL BONE). AN ANALYSIS OF 552 CASES. McKenna, Robert J.; Schwinn, Charles P.; Soong, K. Y.; Higinbotham, Norman L. J. Bone Joint Surg., 48-A: 1-26(Jan. 1966).

Among the 552 cases considered, there were 22 cases of sarcoma believed to be caused by ionizing radiation. Irradiation-induced osteogenic sarcoma, by definition, is an osteogenic sarcoma that fulfills the following criteria. The sarcoma must be confirmed by microscopic examination; it must arise within a bone that has received at least 3000 rad five or more years prior to development of the sarcoma; the patient must have had an asymptomatic latent period following irradiation therapy; and the bone at the ultimate site of the sarcoma must have been roentgenographically normal or the site of a histologically proved benign condition. The 22 irradiation-induced osteogenic sarcomas in this series were either pleomorphic osteosarcomas or fibrosarcomas; there were no chondrosarcomas. Twenty patients had received irradiation therapy for pre-existent benign or malignant conditions and two were radium-dial painters. Of the 552 patients, 417 were treated by surgical ablation; of the patients so treated, 141 received preoperative irradiation. Various sources of radiation during the years covered by this study (1925 to 1955) were used, including radium element pack, 200-kv and 1-MeV machines, and ^{60}Co sources. Each was used in an ~ equal numbers of cases. Tumor dose varied from 1500 to 12,000 rad and was followed by surgical ablation from one day to many months after completion of radiation therapy. Irradiation, used as the sole therapy for 47 patients, produced no cures. Preoperative irradiation followed by amputation did not prove as effective as amputation alone. Ninety-eight patients (17.8% of the total) with osteogenic sarcoma were long-term survivors, that is were alive and well from 5 to 34 yr after treatment. (BBB)

10944 TECHNIC AND INDICATION FOR RADIOTHERAPY WITH SEALED BETA IRRADIATORS: CONTINUATION AND

CONCLUSION. Schlungbaum, W. (Staedtische Krankenhaus, Berlin-Spandau, Ger.). Roentgenpraxis, 18: 229-36(Oct. 1965). (In German).

The use of sealed radiation sources for treatment of hemangiomas is described, and the doses required for successful treatment of various skin lesions are considered. (TSS)

10945 OBSERVATIONS ON THE USE OF THOROTRAST IN CAROTIDOGRAPHY (COLLECTIVE REVIEW ON LATE GENERAL AND LOCAL DAMAGE PROVOKED BY THOROTRAST AND CASE REPORT). Chianura, G. (Univ., Bologna). Clinica (Bologna), 25: 28-39(Sept. 1965). (In Italian).

The case history is reported of a previously undocumented case of Thorotrastoma. The patient, 47-yr-old, had undergone carotid arteriography 15 yr previously, wherein ~ 10 ml of Thorotrast had been injected in the left carotid. At recent examination bilateral cervical Thorotrastoma was discovered. Moderate swelling of the neck was evident, and the ThO_2 deposits were confirmed by radiography. (TSS)

10946 ON A CASE OF RADIATION SICKNESS OF UNUSUAL SEVERITY IN A HYPERSENSITIVE SUBJECT. Merialdi, A. (Univ., Genoa). Quad. Clin. Ostet. Ginecol., 16: 580-4(Aug. 1961). (In Italian).

The case of a 61-yr-old woman who developed a severe reaction to radiotherapy for Stage III cervical carcinoma is described. She was treated with intracavitary radium in two applications administered 11 days apart. This was followed, beginning 6 days later, by 17 treatments with 180-kv x-rays for a total of 3000 R (parametrial depth dose = 2500 R). During the course of therapy she experienced nausea, anorexia, hypotension, and psychic depression. Various supportive therapy was given, such as vitamin supplements and antibiotics. Three months after radiotherapy was completed, severe symptoms developed. These included severe cystitis, resistant to all antibiotics tried, proctosigmoiditis with tenesmus, hemorrhagic phenomena (manifested by capillary fragility and accompanied by thrombocytopenia and heparinemia), marked hepatomegaly, gastric symptoms which precluded oral alimentation, and a general condition which indicated a grave prognosis. However, successful treatment of this case was accomplished with blood transfusions, ACTH, and cortisone, and general measures such as vitamins and high-protein feeding. Cortisone treatment appeared to be particularly important in the patient's recovery. (BBB)

10947 CHANGING CONCEPTS IN THE TREATMENT OF PITUITARY ADENOMAS. Poppen, James L. (Lahey Clinic, Boston). Bull. N. Y. Acad. Med., 39: 21-36(Jan. 1963).

Use of various types of radiation to treat a large number (360) of pituitary tumors is reviewed, with an account of the effects and complications of radiotherapy. The history of the use of radiation for pituitary adenomas is traced. (BBB)

10948 PLANNING FOR PRECANCEROUS SKIN: A TEN YEAR EVALUATION. Epstein, Ervin (Univ. of California, San Francisco). Calif. Med., 105: 26-7(July 1966).

A 10-year follow-up examination of 10 patients with precancerous cutaneous alterations that could be expected to recur (actinic keratoses, radiodermatitis, leukoplakia) revealed that dermabrasion gave excellent results in 4 cases and at least some benefit in 4 others. There were no complications, pigmentary or otherwise, in these patients. The recurrences were in the form of keratoses or leukoplakia in all instances except one in which multiple recurrent basal-cell epitheliomas were noted during the 9 years of observation. The latter patient had actinic damage to his skin. Originally, it was thought that the failures (recurrences) were due to further exposure to the causative agent (sunshine, x radiation, smoking). However, in this survey it was noted that the recurrences developed promptly (usually within 3 months to 2 yr). Since the patient would not be likely to encounter sufficient amounts of these carcinogens within so short a period to explain such changes, it is likely that the recurrences are due to the nature, severity, and depth of the condition (chronic radiodermatitis, severe actinic keratoses and epitheliomas) or to technical factors (too shallow planning). (TSS)

10949 COMPUTER METHOD FOR RADIATION TREATMENT PLANNING. Siler, William; Laughlin, John S. (Memorial Hospital for Cancer and Allied Diseases, New York). Commun. ACM (Ass. Comput. Mach.), 5: 407-8(July 1962).

A new method of automatic computation was sought that would accomplish three objectives: reduce required data input to a minimum, permit automatic plotting of isodose curves of the radiation field resulting from all practical combinations of ports; and permit taking into account the effects of body inhomogeneities (e.g., bones, lung and muscle). A special-purpose switching device was designed to be connected to and controlled by the accounting machine, permitting automatic rotation of the sampling grid for the dose matrix, reducing the data input by a factor of about 30. This would have reduced the punched-card library to manageable levels, but would not accomplish the aims of automatic plotting and calculation of effect of body inhomogeneities. Accordingly, a completely new description of the radiation field was devised that would permit these ends to be achieved. A rotation model is given that is suitable for an analog computer and was originally so programmed. However, the greater power and flexibility of the digital computer for general medical work caused abandonment of the analog-computer work. Flow charts for the program are available. (BBB)

10950 A CONTRIBUTION TO THE STUDY OF THE RADIOPROTECTIVE EFFECT OF CYSTAMINE ON HEMATOPOIETIC STEM CELLS. Tkadlecek, L.; Juraskova, Vera (Military Inst. of Medical Research and Postgraduate Study, Hradec Kralove, Czechoslovakia. Inst. of Biophysics, Brno). Folia Biol. (Prague), 12: 278-82(1966).

The protective effect of cystamine on the growth of transplanted hematopoietic stem cells in the spleen of irradiated mice was studied. By the method of analyzing colonies of hematopoietic tissue cells it was found that at an exposure rate of 192 R/min x radiation the protective effect depends significantly on the interval between intraperitoneal injection of cystamine and irradiation. The highest effect was found when 160 mg of cystamine kg/body weight was injected at an interval of 3 minutes before irradiation where the DRF (dose reduction factor) was 2. When the interval was extended to 7 and 11 minutes the DRF decreased to 1.8 and 1.7. At an interval of 1 hour between injection of 120 mg of cystamine/kg/body weight and irradiation and DRF was 1.24. (auth)

10951 EFFECTS OF THORAZINE ON ELECTROENCEPHALOGRAMS IN X-IRRADIATED RATS. Lott, James R. (North Texas State Univ., Denton). Tex. J. Sci., 18: 57-64(May 1966).

The effects of whole-body x irradiation on waveform patterns of electroencephalograms (EEG) of rats were studied. In rats irradiated at 35 R/min, amplitude and frequency changes in pattern tracings were immediately observed. At 15 min postirradiation, a return to control patterns was noted. All rats showed slight decreases in rectal temperature with no significant change in respiration. The effects of Thorazine (12.5 mg/kg body weight) on EEG patterns from the motor cortex of x irradiated rats were found to be fluctuation changes in both the frequency and amplitude of the potentials with no return to control patterns after three hours. In rats that had received 525 R x irradiation, a change in the EEG pattern continued for three hr after injection with Thorazine. Return to control patterns was not observed during this time period. Decreases in the rate of respiration and rectal temperatures occurred in all animals. Effects of x irradiation on Thorazine-injected rats were increases in both the frequency and amplitude of the motor cortex discharge. This response lasted for 3 hr. An immediate change in EEG patterns occurred when Thorazine was injected; the changes were sustained for 30 min. Rats injected with Thorazine were x irradiated and an abrupt change was noted in the Thorazine-induced waveforms that lasted three to five min. Wave forms then returned to that obtained with Thorazine injection. Later, waveform patterns unlike any others observed and that lasted for ~ two hr postirradiation were noted. Significant changes in electrocardiogram patterns were not observed at any time. Therefore, changes in EEGs brought about by x irradiation indicated that a drug-radiation interaction occurred when Thorazine, a tranquilizing agent, was administered prior to or following x irradiation. (TSS)

10952 TREATMENT BY TRANSFUSION OF SEVERE GENERAL RADIATION INJURY IN DOGS. Collins, J. A.; Hechtman, H. B.; Theobald, T. J.; Blumenstock, D. A.; Thomas, E. D., Ferrebee, J. W. (Mary Imogene Bassett Hospital, Cooperstown, N. Y.). Transfusion, 6: 134-9(Mar.-Apr. 1966).

The effects of transfusion of fresh whole blood were observed in 55 dogs exposed to 1250 R of continuous total-body γ radiation. Seven controls received the same basic care, fluids and antibiotics, but no transfusions. The amount of blood administered ranged from 100–150 ml in daily infusions through exchanges of 71 or more repeated once or twice. Transfusion increased survival time but hazards were apparent. The anesthesia and surgical procedures required for the larger exchanges of blood led to complicating infections. Large amounts of fresh unirradiated blood induced early return of hematopoiesis, apparently by implantation of cells present in the blood administered, but jaundice and serious liver injury also occurred, perhaps as a reaction of foreign cells against their host. Best results were obtained by frequent nontraumatic administration of small amounts of blood, equivalent to ~$^1/_{10}$ of the dog's blood volume daily. There were two long-term survivors. One received irradiated blood and the other received blood from a littermate. When histocompatibility is adequate, fresh blood can be used without irradiation and will hasten marrow recovery. When the histocompatibility of donor and recipient is unknown, frequent nontraumatic administration of irradiated fresh blood is helpful and free from injurious effects. (BBB)

10953 IMPLANTATION OF RADIOYTTRIUM IN THE THERAPY OF HYPOPHYSEAL TUMORS. Buraggi, Gianluigi; Marano, Pasquale; Miserocchi, Enrico; Romanini, Attilio (Univ., Milan). Tumori, 51: 131-51(Mar.–Apr. 1965). (In Italian).

Clinical results and complications obtained by implantation of ^{90}Y seeds in patients with hypophyseal tumors are presented. Advantages and limits of this method are discussed and compared with those obtained by other methods. In comparison with surgical hypophysectomy there is the advantage of less trauma. With external radiotherapy, there is the possibility of irradiating the sella turcica with an excessive dose. The dose necessary to destroy the neoplastic tissue is lower than that used for irradiation of normal pituitary tissue to attain total hypophysectomy. Consequently, the treatment schemes elaborated for the 10 cases presented aimed to give to the sella turcica a dose superior or equal to 20,000 rad. Through the evaluation of the postimplantation dose, it was possible to establish that the perisellar area had received a dose of only 2000 to 3000 rad. Nevertheless, persistent improvement in patients who had a reduction in the visual field was obtained. In 7 cases a long-lasting remission was obtained, in 2 a transitory one, and in one case no improvement. Complications included 3 cases of transitory diabetes insipidus and one case of hemiparesis. The visual fields before and after ^{90}Y implantation are shown. (BBB)

10954 ISOTOPE TECHNIQUE FOR MEASUREMENT OF CENTRAL AND ISOLATED PULMONARY ARTERIAL AND VENOUS BLOOD VOLUME IN DOGS. Liu, Chi Kong (Harbor General Hospital, Torrance, Calif.); Johnson, Delores; Astone, Robert; Ackay, Mehemet M. Med. Res. Eng., 5: 7-12(Second Quarter 1966).

A new, radioisotope method was devised to quantitate the isolated pulmonary arterial and venous blood volume as well as to estimate the quantitative relation between the isolated pulmonary blood volume and the central pulmonary blood volume in anesthetized dogs. Using a 512 channel analyzer and two special probes, simultaneous intravenous injection of two radioisotopes, ^{131}I and ^{125}I, is employed; ^{131}I is used for right and left heart radiocardiograms and ^{125}I is used for radiopulmonograms with simultaneous direct sampling dilution technic in the pulmonary artery and the left atrium or in the right ventricle and left ventricle. This technic gives reproducible indicator dilution curves reflecting cardiac and pulmonary circulations. The ^{125}I probe records the radioactivities of the peripheral lung tissue where the pulmonary capillaries are in abundance, but avoids the radioactivity from the heart and great vessels. The radiopulmonogram recorded in this manner represents only the peripheral pulmonary circulation of the lung tissue under the ^{125}I probe and does not represent the total pulmonary circulation of the lungs. For the radiocardiogram ^{125}I is unsatisfactory because of its low energy, low penetrance characteristics, and the fact that it does not represent the total radioactivities of the heart. Simultaneous injection of a mixture of ^{125}I, 100 μC for the radiopulmonogram, and ^{131}I, 25 to 30 μC for the radiocardiogram, gave the best results. (BBB)

10955 INVESTIGATION OF THE REGIONAL VENTILATION AND THE BLOOD FLOW IN THE LUNGS WITH THE AID OF ^{133}Xe. Kalantarov, K. D.; Korsunskii, V. N.; Belyakov, V. A.; Gulyaeva, E. G.; Agranat, V. Z.; Trakhtenberg, A. Kh. Med. Radiol., 11: No. 12, 14-20(Dec. 1966). (In Russian).

Detection of ^{133}Xe γ radiation was accomplished by means of a unit developed for medical use that includes the following subassemblies: seven scintillation elements provided with a photomultiplier and a crystal; a multichannel radiation meter; and two triple-channel self-recording galvanometers. Examinations were made of 72 patients with diverse pulmonary affections during the postoperative period. Use of ^{133}Xe permits studies of ventilation and circulation both in the entire lung and in its individual areas. Within the framework of a single procedure, it enables estimation of ventilation and circulation in the same areas of the lung. (auth)

10956 DETERMINATION OF THE ABSORPTION CAPACITY OF THE SMALL INTESTINE BY MEANS OF RADIOINDICATION. Frank, Yu. P.; Mushina, L. N. Med. Radiol., 11: No. 10, 31-6 (Oct. 1966). (In Russian).

In order to study the absorption function of the small intestine in chronic enterocolitis the authors employed a method of radioindication with ^{131}I-labeled sunflower oil. The latter in a gelatin capsule holding 0.5 to 1 cm^3 in a quantity of 25 μC was given to the person investigated together with the breakfast and 50 gm of barium sulfate. To determine the accumulation of radioiodine in the blood the authors took venous blood samples 1, 3, 4, 5, and 6 hours after the radioactive breakfast. Parallel with this the patient was subjected for a period of three hours to x ray investigation. In a number of cases deviations in the blood radioactivity curve were associated not only with disturbance of the absorption function of the small intestine, but also with disorder of the evacuatory function of the gastrointestinal tract. Roentgenological investigation was conducive to a more correct interpretation of blood radioactivity alterations. (auth)

10957 LOCALIZATION TEST OF THYROID GLAND WITH ^{132}I. Guntermann, S.; Mitterlechner, E. (Univ., Berlin). Radiol. Diagn., 7: 347-53(1966). (In German).

The replacement of ^{131}I by ^{132}I, especially in scintigraphy of thyroid gland, depends on a number of physical and physiological conditions. The main difficulties in the use of ^{132}I and the means to overcome them are described. The possibility of individual variation of dosage of ^{132}I is particularly pointed out. The technical parameters of recording are kept almost constant, so that the scintigrams can be compared with one another qualitatively. The decisive advantages in the use of ^{132}I in scintigraphy of thyroid gland are the considerable reduction of radiation dose and the rapid availability of results. (auth)

10958 RADIATION INDUCED NEOPLASMS FOLLOWING CURATIVE THERAPY FOR RETINOBLASTOMA. Soloway, Henry B. (Presbyterian Hospital, New York. Columbia Univ., New York). Cancer, 19: 1984-8(Dec. 1966).

Twenty-two cases of radiation induced neoplasms following curative therapy for retinoblastoma are reviewed, and three new cases are reported. Twenty-four of the 25 growths were malignant, and most were of the osteogenic series and its variants. The young age of the patients at the time of radiotherapy had no apparent effect upon the length of the latent interval, as persons receiving radiotherapy in adulthood had similar latent periods preceding the development of similar tumors. The prognosis of these tumors was exceptionally poor, in part due to the large proportion of sarcomas and also due to the proximity of the tumors to the deep structures of the face and base of the skull. (auth)

10959 POSSIBLE MODE OF ACTION OF PANTOTHENIC ACID IN RADIOPROTECTION. Dombradi, G. A.; Szepesvari, E.; Szorady, I. (Medical Univ., Szeged). Acta Physiol. Latinoamer., 14: 327-9(1964).

Pretreatment with pantothenic acid results in a 200% increase of survival time in total-body irradiated mice. An important radioprotective substance is mercaptoethylamine or cysteamine, and this substance is a component of coenzyme a together with pantothenic acid. As cysteamine is an antimitotic agent, attempts were made to determine whether pantothenic acid possesses a similar activity, for a better understanding of its mode of action. Male Swiss mice received intraperitoneally various doses of pantothenic acid, as Ca pantothenate, varying on a logarithmic scale. Doses were chosen so as to span a large dose interval from minimal physiological dose to the LD_{50}, 920 mg/kg by the intraperitoneal route in mice. The number of mitoses per 1000 bone marrow cells was counted 6 hr later to detect the possible cytostatic effect of the compound. On the basis of the results, it seems probable that in the radioprotective activity of the coenzyme a, the active agent is the cysteamine moiety, while the role of the pantothenic acid is of a secondary nature. This may be due to its position in the coenzyme a molecule, leading to the possibility of enhanced coenzyme a synthesis. This concept may be supported by the fact that the radioprotective effect of pantothenic acid was most marked if total-body irradiation was done after 7 days treatment with pantothenic acid. (TSS)

10960 PREPARATION OF ^{32}P-LABELED RESIN MICROSPHERES FOR RADIATION TREATMENT OF TUMORS BY INTRA-ARTERIAL INJECTION. Caldarola, L.; Rosa, U.; Badellino, F.; Sosi, S.; Cavalli, A. (Istituto di Oncologia, Turin). Panminerva Med., 7: 102-6(Apr. 1965).

A method is described for the preparation of a radioactive product, for the intra-arterial treatment of malignant tumors, formed by particles of ion exchange resin labeled with ^{32}P. A method of preparation was devised which consists in adsorbing Cr^{3+} on to a cation exchange resin; Cr^{3+} is then transformed by bringing the suspension to pH 9. When this is carried out in the presence of ^{32}P (in the form of Na_2HPO_4), a complex of Cr(III) and phosphate ion is formed. Three mg of resin labeled at low sp act. (100 μC of ^{32}P), suspended in 0.5 ml of glycerine, was injected into rabbits. The animals were sacrificed after 1, 15, and 30 days after the injection. The preparation was found to be stable in vivo and in vitro tests. Advantages of this ^{32}P-labeled resin over ^{198}Au and ^{90}Y particulate preparations for intra-arterial radiotherapy are enumerated. (BBB)

10961 COMBINED TELECOBALT AND 5-FLUOROURACIL THERAPY IN CANCER OF THE STOMACH. Falkson, G.; Sandison, A. G.; Jacobs, E. L.; Fichardt, T. (Pretoria General Hospital). S. Afr. Med. J., 37: 712-17(July 6, 1963).

Radiotherapy from either a 250-kv x-ray or ^{60}Co unit was used in combination with this potentiating cytostatic agent. The radiation dose administered had to be considerably smaller to produce the same biological effect to be expected from a more radical dose. These seemingly smaller doses do not indicate that inadequate radiotherapy had been administered. Under potentiation from cytostatic agents, especially the antimetabolite 5-fluoro-

uracil, the seemingly small doses from telecobalt and deep x-ray therapy stop just short of a radical dose following a single course, and after repeated courses at intervals of 5 to 6 weeks over a period of a year or more, the dose administered is cytostatic if not actually cancerocidal, as proved by the disappearance of the tumor or metastases. The results confirmed that by combining telecobalt therapy with 5-fluorouracil, it is possible to give a lower dose of each agent and still produce the desired biological effect, owing to the potentiating effect of these two agents upon one another. By use of combined therapy it was possible to eliminate some of the severe toxic effects which follow adequate therapy by each agent on its own. Good results were obtained by combining small doses of telecobalt therapy with small doses of 5-fluorouracil. Other radiation and cytostatic agents, either singly or in combination, did not produce the same degree of remissions. Side-effects of the treatments are described. (BBB)

10962 TREATMENT OF PATIENTS AFTER THERAPEUTIC ABLATION OF THE PITUITARY. Pearson, O. H. (Western Reserve Univ., Cleveland). Mod. Treatment, 3: 205-14(Jan. 1966).

Complications resulting from ^{90}Y implantation in the pituitary and the treatment of patients who have undergone radioinduced destruction of this gland are described. In all patients undergoing transsphenoidal surgery or implantation, prophylactic antibiotic therapy should be given for 1 day before and for 7 days after surgery. Cortisol replacement therapy is most critical in the immediate postoperative period since pituitary-adrenal function ceases promptly, and the stress of surgery produces an increased demand for cortical hormone. With ^{90}Y implantation, cortisone replacement therapy is unnecessary preoperatively or during the first 24 hr postoperatively since adrenal insufficiency does not develop until 36 to 72 hr after implantation. The half-life of ^{90}Y is about 2.5 days, so that 50% of the radiation dose has been delivered at that time, 75% at 5 days, and so on. Yttrium-90 implantation is a minor surgical procedure in contrast to surgical hypophysectomy, and thus less cortisone is needed in the postoperative period. Thyroid replacement therapy is not required until about one month following hypophysectomy, and in females, gonadal replacement therapy is not regularly required. In the male, testosterone replacement therapy is essential, and is usually started 1 to 2 months after hypophysectomy. Seizures are a potential risk following craniotomy and ^{90}Y implantation. Anosmia sometimes occurs when the transfrontal approach is used since one olfactory nerve is usually sacrificed. Subdural hematoma, frontal lobe injury, damage to the optic tracts or oculomotor nerves, and rhinorrhea are extremely rare complications. With the transsphenoidal approach to the pituitary, rhinorrhea and meningitis are potential complications. Although a screw-implantation technique has been designed to eliminate rhinorrhea, it may still occur in 10 to 15% of patients. This usually occurs at about one month after implantation, and in most cases subsides spontaneously within a few weeks. (BBB)

10963 RENAL EXCRETION RATE OF ^{131}I DURING ADMINISTRATION OF LARGE DOSES OF INACTIVE IODIDE. Rossing, N.; Andersen, S. B. (Clostrup Hospital, Copenhagen). pp 116-22 of Physiology and Pathophysiology of Plasma Protein Metabolism, Proceedings of the Third Symposium, Grindelwald, Switzerland, September 10-12, 1964. Bern, Verlag Hans Huber, 1965.

The excretion rate of radioiodide in 16 normal subjects and in 7 with renal disorders was studied. The size of the iodide pool was calculated and the recovery of ^{131}I was measured. A dose of 50 μC of ^{131}I was given intravenously. During the study 500 mg of inactive iodide was given daily. Blood samples were drawn after 15 min, 3 hr, 10 hr, 24 hr, 36 hr, 48 hr, and 72 hr. Urine was collected in 12-hr portions, and fecal output of radioiodide was measured in two subjects. The amount of activity retained in the body was examined by whole-body counting in 10 individuals. The mean radioiodide clearance was 40 ml/min and the urinary recovery was 95%. Fecal excretion did not exceed 0.1% of injected dose. In a patient with renal disease, excretion rate of iodide was much lower than in normals. Whole-body counting showed that less than 1% of the injected dose was retained after 3 days. This suggests that iodide is lost by other routes, probably through the sweat. A linear relation seemed to exist between endogenous creatinine clearance and radioiodide clearance. (BBB)

10964 THE THERAPEUTIC EFFICACY OF PRESERVED BONE MARROW TRANSPLANTATION IN THE EXPERIMENTAL THERAPY OF ACUTE RADIATION SICKNESS. Kevlishvili, G. E.; Egnatashvili, Sh. V.; Abesadze, A. I.; Tkeshelashvili, T. V. Probl. Gematol. Pereliv. Krovi, 11: No. 10, 37-9(Oct. 1966). (In Russian).

Experiments were carried out on dogs x irradiated with fatal doses (600 R). Bone marrow was transplanted into the bone on the third day after irradiation. Preserved bone marrow gave the same therapeutic effect in acute radiation sickness as freshly prepared marrow. However, medullotransfusion alone was incapable of restoring the disturbed protein metabolism, which is marked in this disease. The latter was treated by protein blood substitute transfusion (colloid infusin or gelatin solution). Along with favorable hematologic effect, the combined therapy gave a complete normalization of the blood serum protein composition and considerably increased the survival percentage of fatally irradiated dogs. (auth)

10965 LATE HISTOPATHOLOGICAL CHANGES IN KIDNEYS OF GRID-IRRADIATED MICE. Bucci, Thomas J.; McLaughlin, Mary M.; Conant, Charles N.; Krebs, Adolph T.; Woodward, Kent T. (Walter Reed Army Medical Center, Washington, D. C.). Strahlentherapie, 131: 352-60(Nov. 1966).

Mice irradiated with high doses (1100, 2000, and 3000 R) of x ray through lead grids were observed for many months following exposure. Animals were examined at intervals for gross and microscopic changes. Grid-shielded mice maintained their healthy appearance throughout the experiment. Grid patterns of epilation appeared in the fur within a few weeks, but the earliest gross evidence of an internal grid pattern was seen only after 11 months in kidneys of mice exposed to 3000 R. In animals exposed to lower doses this was delayed. Typical radiation nephropathy can be produced in focal areas corresponding to the grid pores. The intervening renal tissue of the same kidney is then available as control material. It is suggested that this technique may be of considerable value in separating changes due to aging from changes due to radiation in the kidney, and perhaps in other organs as well. (auth)

10966 A CONTRIBUTION TO STUDIES ON RADIOACTIVE PHARMACEUTICALS. Mitchell, Joseph S. (Addenbrooke's Hospital, Cambridge, Eng. Cambridge Univ., Eng.). Strahlentherapie, 131: 331-41(Nov. 1966). (In German).

This report deals with the most recent results of the clinical and laboratory studies of the possibility of using tritiated derivatives of Synkavit, especially TRK 219, tetrasodium 2-methyl-1,4-naphthohydroquinone-diphosphate, as a therapeutic agent. The evidence is based on 150 seriously ill patients with very advanced recurrent inoperable malignant tumors and reticuloses. In general, the results of treatment have been relatively modest. The practical dosimetry is discussed in some detail. In most of the cases only palliative treatment was possible. However, in certain cases, curative levels of radiation dosage could be delivered, especially after intra-arterial administration. In certain cases of advanced malignancy, unusual cells which concentrate the radioactive drugs are present in the bone marrow. Although they resemble tumor cells, much further work is necessary to identify them. (auth)

10967 HEAVY PARTICLE RADIATIONS: SOME THERAPEUTIC CONSIDERATIONS. Hazel, J. J. (Royal Victoria Hospital, Montreal); Lawrence, J. H.; Tobias, C. A. J. Can. Ass. Radiol., 17: 158-61(Sept. 1966).

High energy heavy particle radiations are described and their unique absorption characteristics (great penetration with little scatter, and higher specific ionization with greater RBE at their termination in tissue at the Bragg Peak) noted. Associated biologic advantages at the cellular level, relative lack of oxygen enhancement and of tissue recovery, and possible greater effect on higher ploidy malignant cells than normal tissue are enumerated. Use of heavy particle beams for pituitary irradiation and in tumor therapy to date is cited. Future trends in particle therapy are seen as possibly combined with conventional radiation in tumors with anoxic foci and resistant tumors. The development of higher energy heavy ion linear accelerators may allow elimination of the oxygen and cellular recovery effects in tumor therapy. (auth)

10968 REPRESENTATION OF A PARATHYROID GLAND ADENOMA WITH ^{75}Se-METHIONINE AND SCINTILLATION CAMERA. Sack, H.; Petry, R.; Duewell, H. J. (Univ., Muenster, Ger.). Deut. Med. Wochschr., 90: 2353-4(1965). (In German).

The clinical picture of a primary hyperparathyroidism is nowadays quite clear. Localization of the basic parathyroid gland adenoma is usually the major problem. Hitherto this has been the surgeon's problem and under unfavorable conditions he may fail to detect a small adenoma even with the best preparative technique. Recent literature contains references to diagnostic localization by means of radioisotopes, using 1-methionine in which a sulphur atom is replaced by γ-emitting ^{75}Se. The present paper reports the case of a 77 year woman with suspected hyperparathyroidism. After an injection of ^{75}Se-methionine and the taking of scintigraphs with a scintillation camera, an adenoma was localized and extirpated. Anger's scintillation camera proved superior to customary scintiscanning. (UK)

10969 NUCLEAR WEAPON ENVIRONMENT. Moore, Robin G. (Army Electronic Proving Ground, Fort Huachuca,

Ariz.). pp 41-7 of Institute of Environmental Sciences 1966 Annual Technical Meeting, Proceedings. Mt. Prospect, Ill., Institute of Environmental Sciences, 1966.

Shock, blast, thermal radiation, and nuclear radiation are discussed as the basic elements of a nuclear weapon environment. The relative effects of these elements on both personnel and materiel are summarized. The mechanisms of interaction between nuclear radiation and matter are described. In particular, the effect of nuclear radiation on electronic equipment is discussed. In the event of nuclear warfare, the popular conception that all will be lost is not a fact. Humans, with adequate protection from residual nuclear radiation, will be relatively safe unless they are in the proximity of ground zero. Materiel, such as electronic equipment, can, within limits, be protected from nuclear radiation through hardening techniques. (auth)

10970 DOES POSTOPERATIVE IRRADIATION IMPROVE SURVIVAL IN LUNG CANCER? Sherrah-Davies, Evan (Christie Hospital, Manchester, Eng.). J. Amer. Med. Ass., 196: 345-7 (Apr. 25, 1966).

Theoretical bases for postoperative irradiation in Stage II bronchiogenic carcinoma are considered with reference to a clinical study of 200 cases, half were treated by surgery only, the other half by surgery plus postoperative irradiation to the mediastinum. Three fields of 10 × 5 cm were used, giving a tumor dose of 4500 rad in three weeks from a 4-MeV linear accelerator. At three years after treatment, there was no statistically significant difference in survival between the two groups. It is possible that the 10 × 5 cm field used was too small. However, if the whole of the anterior, middle, posterior, and superior mediastinum is treated, the volume is such that the dose has to be reduced below the level at which a cancericidal effect can be expected. A compromise has to be made, and it is probable that a cube of 8 × 8 × 8 cm or 10 × 8 × 8 cm at the most is the largest volume which can be given an effective dose. Radiation esophagitis seems to be the limiting factor in mediastinal dosage. (BBB)

10971 THE EVALUATION OF METASTATIC THYROID CARCINOMA WITH ^{99m}Tc PERTECHNETATE. Sodee, D. Bruce. Radiology, 88: 145-7(Jan. 1967).

A patient with metastatic thyroid carcinoma to the lung was studied by scintiscanning following the administration of ^{99m}Tc pertechnetate and ^{131}I. The results imply that ^{99m}Tc, because of its different mode of action, may localize in nonfunctional metastatic thyroid carcinoma. Clinical inferences of the observation are presented. (auth)

10972 ISOSENSITIVE RADIOISOTOPE SCANNING. Hisada, Kin-ichi; Ohba, Satoru; Matsudaira, Masamichi (Kanazawa Univ., Japan). Radiology, 88: 124-8(Jan. 1967).

In the development of a medical universal human counter (MUHC), a concept of isosensitive radioisotope scanning was investigated. The essential feature is the adaptation of two opposed detectors synchronized and moved in a rectilinear scanning system with the output of the two detectors combined to a single recording. The delineation of the radioisotope distribution is completely independent of depth so that any deposition of radioactivity has an equal opportunity to be visualized. This makes the system suitable for the detection of a deep-seated abnormality in a large organ, for multinuclide scanning, and for quantitative estimation of regional pulmonary blood flow in the lung where the evaluation of the entire organ is necessary. The employment of two detectors reduces the amount of radioisotope that must be administered. (auth)

10973 SIMULTANEOUS PERFORMANCE OF ISOSENSITIVE SCANNING AND BILAMINOSCANNING. Hisada, Kin-ichi; Hiraki, Tatsunosuke; Ohba, Satoru; Matsudaira, Masamichi (Kanazawa Univ., Japan). Radiology, 88: 129-34(Jan. 1967).

A new technique was developed to obtain an isosensitive scan and bilaminoscans simultaneously. The essential features are the addition of two detectors placed obliquely to the two opposed-detector system and the means of mixing the signals additively from each detector in three combinations, recording them simultaneously with four heads of mechanical multidot tapper, two sheets of laminoscan upper and lower, one isosensitive scan, and one conventional anterior scan. The system can be helpful in disclosing smaller lesions in an organ of thick dimension. (auth)

10974 THEORETIC BASIS AND EXPERIMENTAL EVIDENCE SUPPORTING PREOPERATIVE RADIATION THERAPY. Powers, William E. (Washington Univ., St. Louis). Proc. Natl. Cancer Conf., 5th, 461-7(1964).

In experiments performed to validate the use of preoperative radiotherapy, various neoplasms were grown as solid subcutaneous tumors in the flank of 6- to 7-week-old female mice. With the KHT tumor and BW10232 tumor, no improvement in survival was seen with the use of one fifth of the curative x-ray dose. The dose of radiation required to cure 50% of mice with the 6C3HED tumor varied from 1700 to 3200 R, depending on the circumstances of the mice before implantation of the tumor. In the group requiring 1700 R to cure 50% of localized subcutaneous tumors, normal C3H/Anf mice were used, and the recurrences observed after either surgery, x-ray treatment, or x-ray treatment and surgery were localized. In the succeeding groups requiring 3200 R to cure 50% of the similar localized 6C3HED tumors, recurrences were often manifest by widespread metastases. In experiments directed to the question of healing delay, animals were randomly distributed into groups to receive either radiation alone, radiation and surgery, or surgery alone and examined daily for evaluation of wound healing as manifest by complete epithelization of the standard incised wound. In the animals which had only x-ray therapy, there was no discontinuity of the skin although a severe dry desquamation and occasional moist epidermatitis was noted. There was no great difference in rate of healing between untreated mice and those receiving 1000 R, although larger doses produced a marked delay and interference with healing. The concept that preoperative irradiation increases the surgical cure in certain tumors has been justified. The use of relatively small doses of preoperative x-ray therapy (much less than curative doses) followed by immediate surgical removal of the tumor significantly increases the cure rate in most mouse-tumor systems. It is concluded that the use of preoperative radiation may be the best contribution to the state of the art of clinical practice available at the present state of the science of cancer and radiation biology. (BBB)

10975 TREATMENT OF INVASIVE CARCINOMA OF THE CERVIX DURING PREGNANCY. Pratt, Joseph H. (Mayo Clinic, Rochester, Minn.). CA, Med. J., 14: 17(Jan.-Feb. 1964).

Hazards to the fetus from radiotherapy for cervical carcinoma are dealt with in a brief discussion of the treatment of this condition. In the first trimester, invasive cancer should be treated with complete disregard for the pregnancy, all consideration being given to selection of the therapy, either hysterectomy or radiation, offering the best prognosis for the mother. In the second trimester, and particularly in its latter part, the hope of preserving viability of the fetus by delay of treatment must be weighed against the steady worsening of prognosis with each month's procrastination. With acceptance of the risk of fetal damage, radium may be utilized prior to the 34th week to hold the malignant growth in check while the fetus matures. In the third trimester Caesarean section is the preferred method of evacuation of the uterus, but low cervical incisions should be avoided as they may conceivably extend into the tumor. If the lesions are of Stage I, or early Stage II, a radical hysterectomy with bilateral dissection of modes should be considered. When the lesion is more advanced or the patient a poor surgical candidate, the uterus should be evacuated by Caesarean section and then a full course of radium and external radiation utilized. (BBB)

10976 RADIOACTIVE STRONTIUM PHOTOSCAN AS A DIAGNOSTIC AID IN PRIMARY AND METASTATIC CANCER IN BONE. Charkes, N. David (Albert Einstein Medical Center, Philadelphia); Sklaroff, David M. Radiol. Clin. N. Amer., 3: 499-509 (Dec. 1965).

Exploratory and diagnostic use of radiostrontiums and other bone-seeking isotopes is reported, their advantages and disadvantages compared, and associated hazards explained. Strontium-85 is a good scanning agent. It is a mono-energetic γ emitter (0.513 MeV) whose photon is readily collimated by currently available commercial detecting equipment. There is no particulate emission (β particles). Its half-life of 64 days allows a convenient shelf-life, it can be administered from a multiple-dose vial without chemical alteration, and it is not unduly expensive. Since Sr closely follows the metabolism of calcium by bone, and its deposition reflects alterations in local calcium metabolism, both destructive and reparative changes in bone induced by the presence of malignant tissue can be demonstrated by means of photoscanning with strontium-85. Results in more than 400 bone scans in patients with malignant disease show that strontium-85 is an excellent agent for the detection of bone metastases. Most radiodensities on roentgenograms and most osteolytic lesions are hot on the scan. A few osteolytic lesions, chiefly those resulting from anaplastic tumors, do not accumulate radiostrontium. Because of its long physical and biologic half-life in bone, the administered dose of strontium-85 is necessarily low, resulting in long scanning times and suboptimal resolution. The use of a strontium isotope with short half-life would be advantageous since millicurie amounts could theoretically be administered relatively safely. To this end, strontium-87m (half-life 2.8 hr) was investigated. Bone scans with this isotope are very similar to those with strontium-85, but because of the short physical half-life, the scan must be begun 30 to 45 min after injection. Since more than 95% of the administered dose is retained within the body during the first two hours, the body background is high. The relatively low delivered dose,

however, permits its use in children in millicurie amounts. Its major disadvantage for routine clinical use is its expense. Strontium-87m is milked from an yttrium-87 generator, which must be renewed every two to three weeks. Fluorine-18 has also been investigated. Like radioisotopes of strontium, it localizes in primary and metastatic as well as in benign bone lesions. Whereas 20 to 40% of radiostrontium is accumulated by bone, 50% of the administered dose of fluorine-18 becomes rapidly fixed in the skeleton, resulting in a higher target-to-nontarget ratio. Unfortunately, its half-life is so short (1.87 hr) that proximity to a cyclotron is almost a necessity for using this useful radioisotope. Another bone-seeking isotope which may prove to be of clinical value is gallium-68 (half-life 68 min). Studies indicate that satisfactory bone localization occurs within 30 min after administration of gallium citrate. (BBB)

10977 POSSIBLE NEW APPROACH TO THE EVALUATION OF RADIATION INJURY OF BONE MARROW. Lee, Hun; Richards, Victor (Presbyterian Medical Center, San Francisco). Nature, 212: 1593-5(Dec. 31, 1966).

The possibility of evaluating radiation injury of the bone marrow by the analysis of changes in the ability of the cells to survive attacks from cytotoxic agents in dye exclusion tests was investigated in mice. The animals were exposed to a whole-body dose of 800R x radiation and then killed at various intervals ranging from 10 min to 22 hr post-irradiation. One femur was then excised and the marrow washed out with a stream of dye solution. The dye solutions included eosin, trypan blue, and desoxycholate alone and in mixtures. A drop of cells suspended in the dye solution was transferred to a slide for immediate microscopic counting of a total of 1,000 cells from each animal. Results indicated that trypan blue stains only dead or severely damaged cells and is probably slightly toxic to cells. Eosin and desoxycholate, in the concentrations used, were highly toxic to bone marrow cells. Eosin invaded the cell but did not always kill immediately. Some cells excluded trypan blue following the invasion of eosin. Few cells killed by radiation remained in the marrow population after the first hr following irradiation. The dead cells were rapidly disposed of by the body. Results indicated that cells sensitive to radiation are also sensitive to eosin and desoxycholate. It is suggested that by counting the cells susceptible to eosin or desoxycholate in vitro the percentage of cells killed by irradiation can be approximated indirectly by comparison with a standard value of non-irradiated marrow. (C.H.)

10978 POTENTIAL ANTIRADIATION DRUGS. III. 2-AMINO-2-ALKYL-1,3-PROPANEDITHIOLS AND 3-AMINO-4-MERCAPTO-1-BUTANOL. Handrick, G. Richard; Atkinson, Edward R. (Arthur D. Little, Inc., Cambridge, Mass.). J. Med. Chem., 9: 558-62 (July 1966).

In a study of pure organic compounds that might protect against the lethal effects of ionizing radiation, simple aminothiols having more than one thiol function were examined. Syntheses and radioprotective properties are described for 2-amino-2-methyl-1,3-propanedithiol, 2-amino-2-ethyl-1,3-propanedithiol, and L-(+)-3-amino-4-mercapto-1-butanol. The two aminodithiols were prepared from available amino alcohols by the procedure of Owen et al., appropriately modified by the use of the tosyl protective group on nitrogen. 3-Amino-4-mercapto-1-butanol was prepared in 30% yield using the thiazoline route. The entire synthesis was carried out from both L-(+)- and racemic aspartic acids. 2-Amino-1,4-butanediol was prepared by the reduction of di-n-butyl aspartate rather than by the reduction of the dimethyl or diethyl esters as used previously. When radioprotective activities of the compounds were tested, both 2-amino-2-alkyl-1,3-propanedithiol hydrochlorides showed good protection toward bacteria, but when administered to mice at 50 mg/kg the protection was not significant against midlethal radiation. L-(+)-3-Amino-4-mercapto-1-butanol showed no protection with bacteria but gave good protection to mice at 351 to 750 mg/kg. (BBB)

10979 RADIATION THERAPY AND YOUR PATIENT. Carpender, J. W. J. (Univ. of Chicago Medical School). J. Iowa Med. Soc., 55: 621-6(Nov. 1965).

Use of various types of radiation to treat cancer is reviewed, with emphasis on the benefits and hazards of high-energy sources. Some conditions are better treated by radiation up to 250 kv than at the higher energy levels. For example, basal- and squamous-cell carcinomas of the skin, including the eyelid and lip, fall into this category. Supervoltage radiation not only delivers a considerable dose to underlying tissues, but the max dose falls at a point some distance below the skin surface, so that it is even possible to underdose such a lesion while giving a large dose to underlying tissue, thus damaging the deeper structures and failing to cure the tumor. In treating superficial lesions the lowest possible quality of radiation must be used to spare the bone marrow. Other hazards occur in the use of supervoltage radiation, particularly in the hands of the uninitiated. Radiation from 2-MeV machines or from cobalt-60 units do spare the skin, and since skin reactions have frequently been the limiting factor in the use of lower-energy radiations, there has been a tendency to give higher tumor doses. The consequence has been severe damage to deep-seated organs from overdoses because of lack of the skin reaction warning. Dangers of radiation damage increase with energy. Because higher-voltage radiation is easier to administer, because the usual skin reaction is not present as a warning sign, and because the patient is not so sick, the radiologist who is uninitiated in such therapy may give excessive doses. Additional training for those who are to use supervoltage equipment will require a reduction in the number of institutions where such treatments can be given. Without properly trained and experienced personnel to run the high-energy machines, more harm than good may result to the patient. Often better results come from an experienced radiologist's using a small stock of radium and an orthovoltage machine than from the neophyte or unskilled person with a new cobalt-60 unit. (BBB)

10980 RADIATION THERAPY OF BREAST CANCER. Chu, Florence C. H. (Memorial Hospital for Cancer and Allied Diseases, New York). Clin. Obstet. Gynecol., 9: 221-34(Mar. 1966).

Improvement of radiotherapy of breast cancer, especially with the use of supervoltage techniques, and prevention complications of irradiation are covered in this report. A proper course of irradiation requires a tissue dose of 6000 rad to the breast in about 6–8 weeks, and about 5000 rad to the lymph node areas. The breast is best treated with medial and lateral tangential fields to avoid unnecessary irradiation of the underlying lung. Supervoltage x-ray or telecobalt therapy achieves the desired tumor dose and minimizes skin reactions and bone complications which are often associated with orthovoltage irradiation. Lung tissue is relatively sensitive to radiation and a moderate dose in the order of 2000 to 3000 rad will produce pneumonitis and fibrosis. Minimal pneumonitis and fibrosis may be asymptomatic, but a large dose to the lung will cause serious injury. Radical mastectomy with or without postoperative radiation therapy remains the favored method of treatment, but the value of preoperative irradiation has not been fully explored. Preoperative irradiation is capable of destroying rapidly growing cancer cells, and those cells not destroyed may be devitalized so that they are unable to metastasize. Radiation produces fibrosis which may wall off tumor invasion, diminish lymphatic or venous drainage, and thus reduce the chances of dissemination. Theoretically, radiation may also alter the tumor-host immunological relation. Technical difficulties of surgical procedures due to radiation reaction and postoperative compilations, such as delayed wound healing, may be increased; however, with modern methods of irradiation the undesirable aspects can be kept minimal. No surgical difficulties occur after a dose of 4000 rad, delivered in 4 weeks. The electron beam, possessing certain physical characteristics, offers definite advantages which are enumerated. Of 135 patients treated for recurrent mammary carcinoma, 100 responded favorably to electron irradiation. In all cases, the electron beam offered ease of obtaining satisfactory dose distribution in the tumor volume and in the normal tissue. Noteworthy was the low dose delivered to the underlying lung. The incidence of radiation pneumonitis and fibrosis with electron irradiation was about 10% as compared to 25% in patients treated for inoperable carcinoma with 1-MeV x-ray tangential technique. In the treatment of chest wall and lymph nodes with 250 or 120 kvp with direct fields, the incidence of pneumonitis and fibrosis may be as high as 60%. Furthermore, the normal skin tolerates the electron irradiation well, even in those patients who had had prior irradiation to the same area, and bone complication is rare. (BBB)

10981 OBSERVATIONS CONCERNING THE EFFECT OF RADIOPROTECTION ON IRRADIATED AND BURNED ANIMALS. Popescu, Gh.; Cavulea, O.; Apostolescu, R.; Miu, C.; Voicu, V.; Chilianu, Gh. Rev. Sanit. Mil., 62: 289-97(Mar.-Apr. 1966). (In Rumanian).

Results are reported from an experimental study to determine the radioprotective effectiveness of cystamine and cystine for burned and irradiated animals. The study, which used 180 mature rats, showed that the protected animals, especially those irradiated with 400 R x radiation, showed a more attenuated evolution of the radiation injuries and a somewhat smaller intensity of histopathologic lesions. The difference in mortality between the protected animals and the controls was not significant. (auth)

10982 RECENT DATA ON THE WAYS TO COUNTERACT EFFECTS OF IONIZING RADIATION. Benes, S. Rev. Sanit. Mil., 62: 505-18(May-June 1966). (In Rumanian).

A review is presented of current data on protection against radiation injuries. Topics discussed include bone marrow transplantation and the related immunologic compatibility problems; attempts to replace bone marrow transplants with homogenates or extracts of DNA, or with DNA and RNA of hemopoietic tissues.

The question of exact determination of irreversibility of toxic radiation effects which are independent of the dose in R and apparently based on individual susceptibility is discussed. (auth)

10983 THE USE OF RADIOISOTOPE ^{90}Sr IN OTORHINOLARYNGOLOGY. Shao, Yen; Hsueh, Shan-i; Yang, Ting-chuan; Chang, Tse-fu; Tien, Chen-ming. Chung Hua Erh Pi Yen Hou K'o Tsa Chih, 12: 263-5(July 1966). (In Chinese).

The authors have employed radioisotope strontium 90 for the past two years in the treatment of 181 otorhinolaryngological cases, including obstruction of the eustachian tube, chronic tonsillitis, lymphoid folliculosis of the base of the tongue, allergic rhinitis, rosacae, rhinitis sicca, and rhinovestibulitis. They believe that this method is comparatively more effective in treating obstruction of the eustachian tubes and chronic tonsillitis. Osteosclerosis and cicatricial narrowing of the tube, however, should not be listed among the indications. The container used for the radiation therapy is an improved model of Beck and Lau. The procedures of the treatment for eustachian tube obstructions and chronic tonsillitis are described. The mechanism of action, reason for the choice of strontium 90, the dosage and protection, the local reaction and side effects are discussed. (JPRS)

10984 COLOR SCINTIGRAPHY OF BRONCHIAL CARCINOMAS. Zita, G.; Brennig, K. (Sonderabteilung fuer Strahlentherapie des Krankenhauses, Vienna). Fortschr. Geb. Roentgenstr. Nuklearmed., 105: 472-9(Oct. 1966). (In German).

The value of color scintigraphy in the diagnosis of bronchial carcinomas is demonstrated. In the case of centrally-located bronchial malignancies, the method permits recognition of deficiencies in arterial blood flow more readily than is ordinarily realized. (H.G.D.)

10985 SYNTHESIS OF POLYPHOSPHAMIDES CONTAINING 2,2'-DIAMINODIETHYL DISULFIDE (CYSTAMINE) RESIDUES. Nifantev, E. E.; Markov, S. M.; Tuseev, A. P. Vysokomol. Soyedin., 7: 1020-3(1965). (In Russian).

Physiologically active synthetic polymers have recently received increased attention. Among these substances are high-molecular-weight polythiols, which serve to prevent radiation sickness. This paper is devoted to phosphorus-containing polymers incorporating 2,2'-diaminodiethyl disulfide, a well-known antiradiation compound. The aim of this work was to obtain antiradiation compounds with prolonged activity. The preparative reaction was the transamidation of tetraethyldiamides of trivalent-phosphorus acids with 2,2'-diaminodiethyl disulfide. The amides of methylphosphorous and phenylphosphorous acids and the corresponding phosphorylated derivatives of 1,2-5,6-glucofuranose diisopropylidene ketal and 1,4-3,6-dianhydromannitol were used as the phosphorus-containing component. The reaction proceeds vigorously at 120–130°C with an almost quantitative liberation of diethylamine. The linear polymers formed in the course of the reaction are viscous oils or vitreous solids; their molecular weight ranges from 5000 to 32,000. They are moderately soluble in dimethylformamide and in chloroform. They are slowly hydrolyzed in water with cleavage of the P–N bond. Treatment with carbon tetrachloride results in cross-linking of the linear polymers, apparently by the Arbuzov reaction: $=P-OR + CCl_4 + RO-P= \rightarrow =P(O)-CCl_2-P(O)=$. Cross-linked polymers were also formed in reactions of 2,2'-diaminodiethyl disulfide with di- and tetrafunctional amides. The kinetics of thermooxidative degradation of the cross-linked polymers were investigated; the results are given in tabular form. (ATD)

10986 INFLUENCE OF THE SIZE OF A RADIATION SOURCE ON THE ISO-RESPONSE LINES OF A MANY-CHANNEL COLLIMATOR. Motzkus, F. (Freie Univ., Berlin). Fortschr. Geb. Roentgenstr. Nuklearmed., 105: 564-6(Oct. 1966). (In German).

Phantom measurements show the influence of extended sources of radiation on the iso-sensitivity lines of a multichannel collimator. As the source becomes larger, the maximum of the response approaches the collimator, a fact that ought to be taken into account with measurements of localization of incorporated radioactivities. (auth)

10987 LUMINESCENT MICROSCOPY FOR DETERMINING RADIOSENSITIVITY OF CERVICAL CANCER CELLS. Vainer, L. L. (Inst. of Experimental and Clinical Oncology, Moscow). Vop. Onkol., 12: 67-70(1966). (In Russian).

Luminescent microscopy was used for determining the prognosis of radiotherapy for cervical cancers in 25 patients. In 20 of the patients changes in tumor-cell luminescence induced by radiotherapy were compatible with morphological changes. No clinical or cytomorphological changes were observed, however, in the five patients in which radiotherapy was not successful. It is concluded that luminescent microscopy may be used for individual evaluation of methods for tumor therapy. (H.G.D.)

10988 PRINCIPLES IN RADIATION HYGIENE AND THEIR APPLICATION TO DENTISTRY. Yale, Seymour H. (Univ. of Illinois, Chicago). Dent. Abstr., 6: 67-72(Feb. 1961).

Literature pertinent to radiation hazards in dentistry is reviewed and the responsibilities of the dentist in maintaining effective radiation protection in clinical practice are examined. In analyzing experimental evidence, it is apparent that genetic damage to the patient during dental roentgenography is probably negligible even when an unfiltered x ray beam is used. However, employing proper filtration, collimation, increased kilovoltage, and using high speed film reduces the danger to an absolute minimum. It is of interest that the gonadal dose measured in 12-yr-old boys was twice that recorded in adults. The newer dental x-ray machines operating at 90 kVp, 15 mA and equipped with electronic timers reduce radiation hazards to a minimum. However, most of the 85,000 dental x-ray machines currently in use in the United States operate at 65 kVp and 10 mA and use mechanical timers. When the electronically timed 90-kVp machine and high speed film are used, exposures are reduced to one twentieth of a sec per film. Consequently, it is possible to make a 20-film full-mouth examination resulting in a total of only 2 to 3 R exposure to the patient's face. In contrast, patients receive an average facial dose of as much as 50 R in many dental offices. With the addition of 1.5-mm aluminum filtration to the 0.5-mm aluminum equivalent inherent filtration in the 65-kVp machine (in lieu of copper-aluminum filtration) patients receive a facial dose of 25 R during a 20-film full-mouth roentgenographic examination. Results of a Chicago survey showed that 22.6% of 122 x-ray machines were collimated and 16.8% were filtered. In another survey of 2000 dental offices, initial assessment of the data provided by 1904 x-ray machines indicated that 68.9% of these machines are collimated and 55.5% are filtered. (BBB)

10989 EXPERIMENTAL EVALUATION OF HEMATOPORPHYRIN IN THE DETECTION AND MANAGEMENT OF INTRAOCULAR TUMORS. Cunningham, Richard D.; Henderson, John W. (Mayo Clinic, Rochester, Minn.). Amer. J. Ophthalmol., 61: 36-44(Jan. 1966).

Hematoporphyrin accumulates in tumor tissue and its red fluorescence can be used to aid in the visualization and delineation of tumors. Effects of the administration of proper dose of hematoporphyrin, a potent photosensitizing agent, on the effects of irradiation on neoplastic tissue was investigated. In view of current attempts to treat intraocular malignant melanomas by ionizing irradiation or photocoagulation, the value of an agent which might enhance the effects of x rays or light on tumor tissue, without increasing the sensitivity of surrounding tissue, is apparent. Possible pigment-enhanced radiosensitivity was studied in two malignant melanomas of hamsters and in an anaplastic squamous tumor (VX-2) of a rabbit. Tumors were implanted into the anterior chambers of one eye in adult male hansters and, 24 hours after implantation, the eye was exposed to x ray doses that varied from 1750 to 4000 R per dose. Animals were examined daily and histological examinations of the eye were performed after death of the animals. Hematoporphyrin was injected intraperitoneally on different days in doses which varied from 0.005 to 0.05 mg/g of body weight. The tumor proved very difficult to treat with radiation because, although it appeared that primary tumor could be controlled by a dose of 3800 to 4000 R, the animals died of metastatic disease. Presumably, a tumor can establish itself and invade uveal vessels in the first 20 hr between transplantation and irradiation or tumor cells can be seeded via the aqueous circulation. A dose of 3400 R had some effect on the primary tumor without inhibiting tumor growth. One-third of the animals that did not receive hematoporphyrin survived the entire time of the experiment; all animals that received hematoporphyrin in a dose of 0.01 mg/g of body weight and 3400 R of radiation survived. In another experiment the radiosensitizing effect could not be demonstrated; therefore, unequivocal evidence of this effect was not obtained. However, results indicated that the hematoporphyrin complex was able to penetrate the blood-aqueous barrier in the eyes of hamsters and rabbits and selectively accumulated in viable intraocular neoplasms. (BBB)

10990 HYPOTHALAMIC CHANGE AND WATER METABOLISM FOLLOWING YTTRIUM, ^{90}Y, HYPOPHYSECTOMY IN MAN. Habener, Joel F.; Dashe, Alfred M. (Univ. of California, Los Angeles). Arch. Neurol., 14: 177-83(Feb. 1966).

Pituitary ablation by stereotactic transnasal ^{90}Y implantation was carried out in patients with advanced metastatic mammary carcinoma. The occurrence of subsequent water intoxication and the ultimate degree of diabetes insipidus varied, indicating that the interruption of the hypothalamico-hypophyseal system was frequently incomplete. The question is: Are these disturbances determined by the degree of pituitary damage or by the degree of retrograde loss of hypothalamic neurons, or both? In this study an attempt was made to correlate diabetes insipidus with hypo-

thalamic damage by assessing the degree of nuclear and neuronal atrophy occurring in the supraoptic (SON) and paraventricular (PVN) nuclei of five patients who died from 5 to 20 months following ^{90}Y hypophysectomy and in whom both anterior and posterior pituitary function had been studied preoperatively and postoperatively. Estimates of degree of pituitary destruction at autopsy were also made. A decrease in the number of neurons in the SON and PVN was found in all five cases and was related to the degree of resulting diabetes insipidus. Two patients developed diabetes insipidus and had the lowest residual SON neuron counts and among the lowest PVN neuron counts. One patient developed mild diabetes insipidus which did not require treatment and had an intermediate decrease in SON and PVN neurons. Two patients did not develop diabetes insipidus, one of whom showed only minimal degeneration of both nuclei while the other had marked SON damage but little loss of PVN cells, suggesting that the PVN produces significant amounts of vasopressin. Little correlation was found between the extent of pituitary destruction and the degree of hypothalamic degeneration and the presence or absence of diabetes insipidus or both. (BBB)

10991 RADIOACTIVE IODINE THERAPY FOR PROGRESSIVE MALIGNANT EXOPHTHALMOS. Bauer, Franz K.; Catz, Boris (Univ. of Southern California, Los Angeles). Acta Endocrinol., 51: 15-22(Jan. 1966).

The use of large doses of ^{131}I (8 to 383 mC, average 76.4 mC) to treat 18 euthyroid patients with progressive malignant exophthalmos is described. Sixteen had been treated by other forms of therapy. Large therapeutic doses of radioiodine were used in an effort to ablate their thyroid glands. In four of the patients no functioning thyroid tissue could be demonstrated; in the others thyroid tissue could still be demonstrated with 5-mC doses of ^{131}I preceded by thyrotropin (TSH). In all patients, marked improvement of the infiltrative changes of ophthalmopathy resulted. The doses of radioiodine required to destroy thyroid remnants were much larger than the doses employed in the treatment of hyperthyroidism. Accordingly, the calculation of the dose was abandoned, and therapeutic doses from 10 to 50 mC were given orally at monthly or longer intervals. In general, if much thyroid tissue was demonstrable in the neck, doses of 10 mC were given to avoid radiation thyroiditis. If there was little thyroid tissue demonstrable, doses of 25 mC, or sometimes 50 mC, were given orally. (TSS)

10992 PROTECTIVE AND RECOVERY EFFECTS OF CHEMICALS ON PLANT GROWTH, CHROMOSOME ABERRATION AND MUTATION IN IRRADIATED SEED OF CROP PLANTS. Biswas, S.; Matsuo, T. (Tokyo Univ.). Radiat. Bot., 6: 575-87(Dec. 1966).

Protection against physiological damages induced by radiation in crop plants was observed with KI and some other K-compounds, cysteine, ferrous sulfate, vitamin C, or Na-ascorbate. Only pretreatment with these chemicals showed protective effect. Some other chemicals used in the present investigation did not show protective or recovery effect, and some chemicals rather acted as radiosensitizers. Chromosome aberrations induced by radiation were decreased by pre-treatment with some K-compounds in the root tip cells of barley. Sodium iodide was also effective in the post treatment. Chemicals effective for physiological protection did not show much effect on grain fertility in general but KI pre-treatment slightly increased grain fertility in barley. Some of the chemicals effective against physiological damage were tested for their effect on radiation induced mutation. It was observed that these chemicals did not decrease the radiation induced rate of mutation, except EDTA-2Na that decreased the rate of induced mutation in rice but not in barley. (auth)

10993 BLOOD FLOW VISUALIZATION WITH THE SCINTILLATION CAMERA. Powell, M. R.; Anger, H. O. J. Nucl. Med., 7: 729-32(Oct. 1966).

Advantages of using scintillation cameras for photographing blood flow and tissue perfusion in man are discussed. Examples of scintiphotos of cerebral and renal blood flow are presented. (H.G.D.)

10994 SPLEEN SCINTIPHOTOGRAPHY WITH ^{99m}Tc SULFUR COLLOID AND THE GAMMA RAY SCINTILLATION CAMERA. Petasnick, Jerry P.; Gottschalk, Alexander (Univ. of Chicago. Argonne Cancer Research Hospital, Chicago). J. Nucl. Med., 7: 733-9(Oct. 1966).

Use of ^{99m}Tc sulfur colloid for splenic imaging is discussed. With a dose of 2 to 3 mCi, excellent quality scintiphotographs with 400,000 dots per picture can be made in one minute or less with the gamma scintillation camera and a 3-inch multi-aperture collimator. Using posterior, anterior, and lateral views, the normal spleen is easily separated from the left lobe of the liver. Because of the frequent association of hepatic and splenic disease, it is often an advantage to examine both organs at the same time. This is rapidly and effectively accomplished with ^{99m}Tc sulfur colloid and the gamma camera. (auth)

10995 DIGITAL COMPUTER ANALYSIS AND DISPLAY OF THE RADIONUCLIDE SCAN. Brown, Donald W. (Univ. of Colorado, Denver). Contract AT-(11-1)-1472. J. Nucl. Med., 7: 740-53(Oct. 1966). (COO-1472-7).

A new method of analysis and display of the data available from the scanner using digital computer techniques is discussed. Pulses from the pulse height analyzer of the scanner are recorded on punched paper tape and are then processed by a digital computer. Pictures of the organ under study are printed out on the computer's printer. One hundred routine clinical scans studied in this way were correlated with simultaneous photoscans and the patient's clinical findings. The results of the computed scans were at least as good as those obtained with photoscanning. A great advantage of computer processing of scans is the ability to quantitate the results of scanning and thus provide information not previously available. (auth)

10996 AN AMPLIFIER PROVIDING FIXED BACKGROUND ELIMINATION AND CONTRAST ENHANCEMENT IN SCANNING SYSTEMS. Clark, R. E. (Veterans Administration Hospital, Cleveland. Western Reserve Univ., Cleveland); Shipley, R. A. J. Nucl. Med., 7: 754-60(Oct. 1966).

An amplifier was designed for producing radioisotope scans of increased contrast through use of fixed background elimination and an internally generated, continuously variable read-out signal that was a function of the net observed counting rate. Scans are shown for comparison of the response of the amplifier with that of a conventional system employing dot factor attenuation. (auth)

10997 PRETREATMENT WITH SELECTIVE BULBAR-DEPRESSIVE DRUGS (CLOPHEDIANOL AND FOLCODINE) AND SURVIVAL OF MICE AFTER WHOLE-BODY IRRADIATION. Stuart, C.; Cittadini, G.; Tomiselli, G. (Univ., Siena, Italy). Boll. Soc. Ital. Biol. Sper., 41: 1063-4(Sept. 30, 1965). (In Italian).

Central nervous system (CNS) depressant drugs have shown to have a radioprotective effect when animals were exposed to high lethal doses of x radiation. The effect of clophedianol hydrochloride and folcodine tartrate, which have a selective depressant effect on bulbar centers, on survival after irradiation was studied in Swiss mice. Mice were injected with 30 mg/kg body weight of either drug 25 min before whole-body irradiation with 200-kv x rays at 46 R/min to total doses of 600 or 800 R. These doses correspond to the $LD_{50/30}$ and $LD_{100/30}$ in control mice of this strain. With the 600 R, $LD_{50/30}$ dose, clophedianol hydrochloride increased mean survival time to 472 hr as compared to a control value of 400 hr; folcodine tartrate increased survival time to 487 hr. These differences were not significant at 99.5 and 95% confidence levels. No radioprotective or sensitizing effects were noted with either drug when the 800 R, $LD_{100/30}$ x-ray exposure was used. It was concluded that bulbar depressants do not appreciably alter the lethal effect of x radiation. (BBB)

10998 FOCUSING COLLIMATORS FOR USE WITH THE HARD GAMMA EMITTERS ^{86}Rb AND ^{42}K. Love, W. D. (Univ. of Mississippi, Jackson); Smith, R. O. J. Nucl. Med., 7: 781-6 (Oct. 1966).

Five- and 8.5-inch thick, 6-hole collimators are described that are suitable for use with ^{86}Rb and ^{42}K respectively. The longer unit gives superior collimation and approximately twice the transmission of the shorter unit. The effective focus obtained in a Masonite phantom with paired opposing scintillation probes is reported. (auth)

10999 ZASHCHITA I VOSSTANOVLENIE PRI LUCHEVYKH POVREZHDENIYAKH. (Protection Against and Repair of Radiation Injuries). Graevskii, Z. Ya.; Ivanov, V. I.; Korogodin, V. I. (eds.). Moscow, Izdatel'stvo Nauka, 1966. 330p.

Forty-four articles discuss problems related to radiation protection and repair of genetic radiation damage in microorganisms, plants, and animals. Repair processes in Escherichia coli irradiated by γ rays and the effects of amino and thiol radioprotective compounds are discussed. The irreversible radiation effects in yeast are also discussed. The nature of the initial chromosome damage in plant cells, the induction of chromosome aberrations by colchicine, and the protective effects of cysteine against radioinduced chromosome aberrations are also discussed. Data are presented from in vitro studies on the mechanisms of action of various radioprotective chemicals; the effects of oxygen on the radiosensitivity of animal tissues; methods of measuring respiration in animal tissues; and the evaluation of various compounds as to their protective effects on mice irradiated with 600 MeV protons. The effects of preliminary treatment with cystamine on the phagocytic activity of leukocytes in the blood of irradiated rabbits were analyzed and the protective action of β-mercapto-

ethylamine, cystamine, homologous blood serum, bone marrow, and spleen transplants in cases of radiation sickness in animals are discussed. (781 references.) (R.V.J.)

Radiation Effects on Animals

Refer also to abstracts 10738, 10740, 10745, 10756, 10761, 10762, 10793, 10800, 10834, 10859, 10887, 10888, 10895, 10939, 10962, and 10977.

11000 (AD-644117) APPARENT ABSENCE OF RECOVERY IN ENDOGENOUS COLONY-FORMING CELLS AFTER IRRADIATION UNDER HYPOXIC CONDITIONS. Phillips, T. L.; Hanks, G. E. (Naval Radiological Defense Lab., San Francisco, Calif.). Oct. 24, 1966. 33p. (USNRDL-TR-1086). CFSTI $3.00 cy, $0.65 mn.

Groups of LAF_1 adult mice were subjected to both graded and divided doses of whole-body x radiation under hypoxic conditions and in air. The endogenous spleen colony-forming unit technique was used to measure the effect of the irradiation on survival of the colony-forming cells. Dose-response curves indicated a D_0 of 122 rads in air and 273 rads under hypoxic conditions, an oxygen enhancement ratio of 2.2. Using 2 doses each of 315 rads in air and of 630 rads under hypoxia, survival ratios were obtained for times between 3 and 36 hours. Animals irradiated in air show peaks in the survival ratio at 9 and at 27 hours. The initial peak is probably the result of early repair within the cell and the second peak that of onset of regeneration. The survival ratio of the animals irradiated under hypoxic conditions was not increased but rather fell slightly at times following the initial point. The results suggest that the degree of early cellular repair is markedly decreased and the onset of proliferation is delayed when radiation injury occurs under conditions of hypoxia. (auth)

11001 (BNL-9494) CELL MIGRATION AND DNA SYNTHESIS IN THE INTESTINAL EPITHELIUM OF THE MOUSE FOLLOWING EXPOSURE TO LETHAL WHOLE-BODY RADIATION. Hopper, Arthur F. (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT(30-2)-Gen-16. 21p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Following 2000 rads of x-irradiation, the cell population of both the crypts and the villi of the small intestine rapidly declines. Cell loss from the crypts during the first 12 hours is the result of both cell death and cell migration, while cell loss from the villi is the result of continued cell migration and sloughing in the absence of any replacement from the crypts. Tritiated thymidine was used as a tracer. Analysis of the labeling index, mitotic index and grain counts at various intervals after irradiation indicates a rapid decline in DNA synthesis immediately—within one to three hours—postirradiation, an abortive increase in proliferative activity reaching a maximum at the end of the first day, and then a rapid decline to the end of the third day. (auth)

11002 (BNL-10722) BULLETIN OF THE MEDICAL DEPARTMENT, BROOKHAVEN NATIONAL LABORATORY. (Associated Universities, Inc., New York). Aug. 1, 1966. Contract AT(30-2)-Gen-16. 77p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Activities of the Medical Department at Brookhaven National Laboratory are summarized. Radiation effects studies are aimed toward elucidation of: radiobiological analyses of hematologic stem cells, blood, and lymph; radionuclide kinetics and measurement in man; antibody response to various challenges; pathogenesis of cataracts and skin lesions; and dosimetry of π^- mesons and mixed fields. Structural and functional investigations of proteins, hormones, and enzymes included studies of syntheses, reaction mechanisms, and bioenergetics. Fine structure, function, and preparation were analyzed in the nucleic acids. Metabolic studies using tracers are described, and kinetics of cellular proliferation are described. Medical studies of persons accidentally exposed in the Marshall Islands incident, computer applications in medical research, and new methods for diagnosis using radiography or isotopic diagnosis are also featured in the program. (H.G.D.)

11003 (CMN-Pub-2/65(Suppl.2)) BASES BIOLOGICAS DA RADIOISOTOPIA E NOCOES DE HIGIENE DAS RADIACOES. ANEXO II. INTERACAO DAS RADIACOES COM AS CELULAS VIVAS. EXPOSICAO AS RADIACOES. (Biological Bases for Radioisotope Use and Concepts of Radiation Protection. Supplement II. Radiation Interactions with Live Cells. Radiation Detection). Domingos do Amaral, Ary; Bitelli, Thomaz (Sao Paulo Univ. (Brazil). Centro de Medicina Nuclear). 1965. 72p. (In Portuguese). DTIE.

Genetics and somatic effects of ionizing radiations are described Radiation effects on human reproductive organs are considered. The pathological biochemistry of irradiated living organisms and the physiopathology of mammals with radiation sickness are described. Some chemical substances that protect against x and γ rays and some substances that intensify the effects of x rays are discussed. (J.S.R.).

11004 (COO-1033-16) BASIC FERTILIZATION PHENOMENA AND GAMETIC LETHALITY IN DROSOPHILA. Technical Progress Report, 1966. (Michigan State Univ., East Lansing). Contract AT(11-1)-1033. 11p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The shift in sex ratio related to paternal age was investigated in X2Y and X3Y Drosophila males with marked Y chromosomes. In X2Y males, the frequency of gametes containing a single chromosome exhibited the same relation to age as was noted in normal XY crosses. In XY gametes, however, one chromosome appeared to dominate the other. Preliminary studies of crosses involving X3Y males indicated that the males were fertile. Frequency of recovery of X- and Y-bearing sperm was shown to be altered by temperature shocks given to mature sperm. X-ray doses of 450 R given to third-instar larvae produced a detectable reduction in frequency of recovery that was related to the frequency of aberration production. (H.G.D.)

11005 (EUR-3164.d) KLINISCHE ANALYSE DES 3,5-TAGEEFFEKTES. (Clinical Analysis of the 3,5-Days-Effect). Horn, W. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Nov. 1966. 20p. (In German). Dep. mn.

The mechanism of radiation death proposed by Rajewsky, in which damage by sub-lethal doses is compensated physiologically in animals whereas a lethal dose results in failure of the compensatory action initiating biochemical processes that lead to death within 3.5 days, was verified experimentally. Uremia caused by radioinduced autolysis was the proof on which verification was based. (H.G.D.)

11006 (RM-5115-TAB) THE POSTATTACK POPULATION OF THE UNITED STATES. Lowry, Ira S. (RAND Corp., Santa Monica, Calif.). Dec. 1966. Contract AT(04-3)-414. 139p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Demographic consequences of a set of five simulated nuclear attacks on the United States are described, and the demographic implications of initial damage into the years following such an event are traced. The demographic variables examined include the size of the postattack population; its rate of growth in subsequent decades; its composition by age, sex, and color; and postattack patterns of fertility and mortality. Simulated attacks and the models and parameters employed for damage assessment are described in considerable detail. The range of alternative outcomes from the five simulated attacks is increased to fifteen by variation of damage assessment parameters. In terms of total fatalities, these outcomes range from 2 to 62 percent of the preattack (1960) population. The possibility of critical survival disparities is examined for such population characteristics as age, sex, and color, within the limitations imposed by a population representation that distinguishes urban, rural nonfarm, and farm residents of each state. Primarily because they occasion higher total exposure to weapon effects, the simulated attacks directed against cities produce greater exposure disparities among sex, age, color groups than do those directed against nonurban targets. Females are relatively more exposed to prompt effects than are males, adults more than children, and nonwhites more than whites. Exposure to radioactive fallout is less consistent. In no case, however, are these exposure disparities large enough to be of much consequence for subsequent estimates of survival disparities within the national population. For the heaviest attack and least favorable sheltering assumption, only 38 percent of the preattack population survives. Analysis of the factors influencing postattack fertility leads to the tentative conclusion that the number of births per thousand persons during the first five years postattack would be considerably lower than preattack. Mortality directly related to weapon effects, including single-dose radiation exposure, would not persist for more than two or three months postattack. The general conclusion from the exercise is that the size of the U. S. population would decline for a period of five to ten years postattack, and increase thereafter. Of the three demographic variables considered, the age distribution and its changes over time appear to have much greater significance for public policy. (H.G.D.)

11007 (SAN-510-2) PERSISTENT RADIATION INDUCED CHROMOSOMAL CHANGES IN NATIVE POCKET MOUSE POPULATIONS OF THE NEVADA TEST SITE. Final Report. Towner, Joseph W.; Lindberg, Robert G. (Northrop Space Labs., Hawthorne, Calif.). Aug. 1966. Contract AT(04-3)-510. 81p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A study was made of the persistence of chromosome damage in wild populations of the Long-Tailed Pocket Mouse, Perognathus formosus, at Nevada Test Site (NTS). Animals were collected 1963 and 1964 from the previously contaminated hills east of the

old ground zeros at Yucca Flat (YF) and from an essentially uncontaminated area north of Jackass Flats (JF). The infinite environmental dose to the YF study area was about 200 R from weapons tests between 1951 and 1958 and perhaps as much as 4000 to 6000 R total cumulative gamma dose from Project Sedan in 1962. Useful cytogenetic data on meiosis, mitosis or both were obtained from 149 animals, including 95 from the contaminated area (YF) and 54 from the control area (JF). No inherited aberrations were detected in the sex chromosomes, the acrocentrics, or the metacentrics Nos. 5, 6, 7, or 10. Inherited numerical aberrations were not found. None of the animals had unequivocal cytogenetic or somatic symptoms of radiation exposure. One of the most important findings of the study was that two animals from the contaminated area (2.4%) and one from the control area (2.2%) had a consistent, presumably inherited, karyotype aberration. All three cases seemed to involve nonreciprocal gain or loss of chromatin from the short arm of a metacentric autosome. All three animals were phenotypically normal and survived for a year or more in captivity. It was concluded that inherited chromosome aberrations were no more frequent in pocket mice from an area at Yucca Flat that had been chronically contaminated by radioactive fallout than in animals from the essentially unexposed habitat at Jackass Flats. (H.G.D.)

11008 (STI-DOC-10/61) LABORATORY TRAINING MANUAL ON THE USE OF ISOTOPES AND RADIATION IN ENTOMOLOGY. Technical Reports Series No. 61. (International Atomic Energy Agency, Vienna (Austria)). Aug. 1966. 144p. IAEA $3.50; S 73,50; Pound 1.1.0; F Fr 14,-; DM 12,25.

General and basic information encompassing the properties of radioisotopes and radiations, the methods of radiation detection, the application and uses of the basic properties of radioisotopes and radiations, and the precautions and procedures necessary for the safety of the individual in the use of radioisotopes and radiations are presented in lecture form. Introductory laboratory experiments are outlined for the use of a Geiger-Muller counter and for the procedure used in evaluating results obtained with the instrument. Exercises designed to familiarize the student with the use and uses of the scintillation counter in regard to crystal scintillation counting, rapid radioactive decay, liquid scintillation counting, and the inverse square law: attenuation of gamma rays are also presented. Another section of laboratory exercises are designed to introduce the student to the supplementary basic principles involved in localization, isotope dilution, tracer kinetics, activation analysis, neutron scattering, and gamma attenuation. An extensive applied section outlines experiments designed for use of radioisotopes and radiation in entomology. Experiments include methods for study of metabolism of ^{14}C-malathion, ^{14}C-DDT, ^{14}C-aldrin, and ^{32}P-labelled systemic insecticides using bio-assay in conjunction with radio-assay; detection of penetration of H_3-labelled insecticides through and into insect cuticle; determination of insect host plant preferences, movement of subterranean insects, insect dispersion, speed of flight and total numbers of insect populations; demonstration of food exchange and transfer of glandular secretions among social insects; demonstration of radiation dosages required to produce sterility in insects, the effect of radiation on the reproductive potential of male and female insects, effect of anoxia on radiation sterilization, and the effect of radiation on insect chromosomes; and use of autoradiography as an entomological technique. (B.H.S.)

11009 (TID-23471) THE LATE EFFECTS OF IONIZING RADIATION ON THE CANINE OVARY. Final Technical Progress Report, 1965-1966. Carlson, W. D. (Colorado State Univ., Fort Collins. Coll. of Veterinary Medicine). Contract AT(11-1)-1390. 37p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress is reported on studies with mongrel dogs and beagles designed: to determine the effects on fertility and reproduction of acute doses of ionizing radiation given directly to the canine ovary; to find the sterilizing dose for the female canine; and to determine histological changes in the irradiated ovary. In both mongrels and beagles there was a gradual decline in overall fertility with increased x-ray dose. Litter size also decreased with dose. Estrous period that appeared clinically normal occurred at all dose levels (2100 to 6000 R) in the beagles, but were much less numerous above 3000 R. In the mongrels observable heat periods occurred at all dose levels through 5000 R, but there was no cyclic activity at 7000 R. Vaginal smears from both groups showed that cytological definition was dependent upon appearance of estrous. The male/female ratio was increased by maternal irradiation from .90 (47% males) to 1.08 (52% males) in beagle populations compared to an increase from 51% males to 52% males in mongrel populations. Mortality was decreased among the pups from irradiated dams in both groups. Organ measurements and histological studies are reported for the beagles. (H.G.D.)

11010 (AEC-tr-6603) RADIOBIOLOGY. Translation of Radiobiologiya, 5: No. 6, 785-936(1965). 238p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Abstracts of 33 articles were prepared from the Russian-language publication Radiobiologiya, 5: No. 6(1965) and appeared in NSA. (C.H.)

11011 (ANL-Trans-386) RETARDED DAMAGE OF SKELETON AFTER ThX-TREATMENT. Spiess, H. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from pp 46-53, Paper VI of Gustav Fischer Verlag-Stuttgart, 1966. 11p. Dep. mn. JCL $1.60 fs, $0.80 mn.

Hazards from the therapeutic use of ThX are discussed. Extensive evaluation showed that a prognosis from an early reaction to irradiation is not possible, although early injuries were evident in hematopoietic function, liver, and kidneys. Observations made in children after protracted ThX treatments revealed a disruption in endochondral ossification and damage to periosteal ossification. Multiple cartilaginous exostoses appeared during the time of maximum longitudinal growth, particularly in the most actively growing portions of the skeleton. The incidence of osteogenic sarcoma was striking, the latent period ranging between 1 and 16 years. It was concluded that both early and latent damage initiated by injections of ThX manifested themselves in a typical recurrent form, distinctive enough to be termed the ThX syndrome. (H.G.D.)

11012 EFFECTS OF IRRADIATION ON BONE-GROWTH OF RATS DURING PROTRACTED PARABIOSIS. Carroll, H. W.; Phillips, R. D.; Kimeldorf, D. J. (Naval Radiological Defense Lab., San Francisco). Int. J. Radiat. Biol., 11: 205-8(1966).

The effects of x-irradiation on bone growth was studied in pairs of rats during protracted parabiosis involving vascular anastomosis. The preparation was used to define some potential mechanisms through which systemic factors contribute to retardation of growth. No demonstrable deleterious effect of irradiation of one partner was sustained by the shielded partner in terms of bone-growth. On the other hand, direct evidence was obtained to show that the bone-growth deficit observed in the irradiated rat 60 days after irradiation was reduced by shielding its parabion partner. The findings are consistent with the concept that the systemic effect on bone-growth is a result of hormonal imbalance rather than the consequence of toxic factors produced by irradiation. (auth)

11013 DISTRIBUTION OF CLONE-SIZES IN SURVIVING AND NON-SURVIVING HeLa S-3 CELLS IN VITRO: POSSIBLE EVIDENCE FOR RADIATION-INDUCED SYNCHRONY. Berry, Roger J. (Churchill Hospital, Oxford). Int. J. Radiat. Biol., 11: 301-4(1966).

In an attempt to test for synchrony in HeLa cells following x irradiation clone sizes were counted and scored as to whether they were odd or even. Irradiated cells had a mean clone size of 8.2 cells and a ratio of odd/even cell numbers of 0.42. Control unirradiated cells had a mean clone size of 18.0 cells and a ratio of odd/even of 0.74. The higher proportion of even celled clones in irradiated cells might be evidence for synchrony. The data also indicate a difference in clone size distribution between irradiated and unirradiated cells. (TSS)

11014 EFFECTS OF X-RAYS ON METAMORPHOSIS AND ADULT LIFE SPAN OF FLOUR BEETLES. Erdman, Howard E. (Battelle Memorial Inst., Richland, Wash.). Nature, 211: 1427-8(Sept. 24, 1966). (BNWL-SA-297).

Tribolium confusum pupae, age 25 to 26 days, were x irradiated. The emergence of adults from pupae given 1 or 2.5 kr was comparable to that of controls. The numbers of beetles unable to complete metamorphosis increased with doses from 5 to 70 kr, but metamorphosis was not delayed. Failure of metamorphosis reached about 35% for 7.5 to 50 kr and about 55% at 70 kr. Mortality of adults increased progressively with increased doses. The mortality approached 100% after 9 days. The possible causes of death induced by radiation are discussed. (H.L.W.)

11015 COMMENTS ON THE INTERACTIONS OF RADIOCOLLOID THERAPY WITH THE RETICULOENDOTHELIAL SYSTEM. Mueller, J. H. (Univ., Zurich). J. Radiol. Electrol., 46: 266-70(1965). (In French).

Histological studies are reported on the effect of colloidal radionuclides on cells of the reticuloendothelial system (RES). Most of the results described were obtained from tissues removed from patients injected with colloidal ^{198}Au for treatment of disseminated cancer. After injection of 125 mC ^{198}Au for peritoneal metastases of ovarian cancer, biopsied peritoneum showed numerous macrophage histiocytes containing ^{198}Au particles, as well as the remains of small metastases which had been radiosterilized, seen as calcified cellular debris. In a region of fibrosis the β-radiation dose was estimated to be 200,000 rad. In a

case of mammary cancer metastatic to the axillary lymph nodes, after treatment with ^{198}Au, the radioactive particles could be seen in lymph node phagocytes providing a dose to the node of ~100,000 rad. Examination of such nodes more than a year after treatment showed regeneration of lymphatic tissue, with proliferation of reticular cells. In some instances this took the form of a benign neoplastic process or reticulosis. In some areas the residual ^{198}Au particles were surrounded by acellular collagenous tissue. (BBB)

11016 STATE OF FOOD DEPRIVATION AS A FACTOR IN RADIATION MORTALITY OF RATS. McDowell, A. A.; Gallo, K. M.; Green, D. C. (Texas A and M Univ., College Station). J. Genet. Psychol., 108: 347-9(June 1966).

The present study explored the effects of various feeding procedures both prior to and following radiation exposure. Forty six-month-old male rats of the chocolate strain of the Univ. of California Laboratories were deprived of food beginning 24 hr before exposure to 900 R of ^{60}Co γ radiation. Three hours before exposure 10 rats were fed, and the food was left in their cages after exposure. At the same time 10 other rats were fed, but the food was removed after exposure. Ten rats received no food for 24 hr before and after exposure. The remaining 10 animals received food after exposure. The four groups differed significantly with respect to survival time during the first 30 days after exposure. The rats of the groups given no food until after exposure survived significantly longer than those of the groups fed just before exposure. These results confirm that increased radiation susceptibility in rats fed just prior to exposure. The findings also indicate that feeding schedules following radiation exposure are not related to susceptibility. (BBB)

11017 VASCULAR AND INTRAVASCULAR EFFECTS OF A PULSED LASER MICROBEAM. Kochen, J. A.; Baez, S. (Albert Einstein Coll. of Medicine, New York). Bibl. Anat., 7: 46-9(1965).

The effect of a fine laser beam on the blood vessels of the rat mesoappendix was studied. The ruby laser unit used was capable of a max output of 120 mJ per pulse of 500 μsec duration. Laser beam intensity was regulated by metallized neutral density filters of known transmittances. The wavelength of the light beam was 6943 Å. Exposure of selected precapillaries to single laser pulses of 0.5 to 7.5 mJ resulted in a two- to three-fold increase in the frequency of spontaneous vasomotion and a progressive increase in reactivity to topically applied epinephrine. The min concentration of epinephrine required to produce contraction of precapillary sphincters decreased progressively from 0.25 to 0.05 μg/ml with increasing laser intensity. These changes in vascular reactivity were not associated with any discernible morphologic vascular lesions or thrombus formation. Laser pulses of higher intensity (15 mJ) resulted in maximally enhanced vasomotion and the transient sticking of platelets and leucocytes to the inner endothelial surface at the site of lasing. When the severity of microinjury was increased, a progressive increase in the number of platelets involved occurred. As the intraluminal platelet mass increased in size, leucocytes became attached in increasing numbers. Within minutes, the expanding thrombus either dislodged in the form of a microembolus or expanded to completely occlude the vessel. Microemboli arising from fragmentation and dislodgment of thrombi frequently lodged in metarteriolar and capillary junctions distal to the site of the injury. Exposure of microvessels to laser beam intensities under 30 mJ did not result in interstitial hemorrhage or distortion of the normal morphology of the outer vascular wall and surrounding tissue. However, single laser pulses of 30 to 60 mJ frequently resulted in decreased vasomotion, localized regions of complete vessel wall breakdown, and varying degrees of interstitial hemorrhage. (BBB)

11018 HEMATOLOGICAL EFFECTS OF INTERNAL IRRADIATION WITH ^{32}P IN MICE. II. CHRONIC RADIATION INJURIES BY REPEATED INJECTING OF SMALL DOSES AND A SINGLE MASSIVE DOSE. Matsumoto, Hikoharu (Kyoto Univ.). Naika Hokan, 11: 1-14(Dec. 1964). (In Japanese).

In dd strain mice 0.5 μC/g of ^{32}P was injected 10 or 15 times, or 4.0 μC/g of ^{32}P once. The mice were observed to determine the incidence of leukemia, or other neoplasms, by examining the peripheral blood at regular intervals. Peripheral erythrocyte, leukocyte, and platelet counts decreased shortly after administration of ^{32}P. These counts showed various trends, some mice showed a quick recovery to the normal level, some showed temporary recovery followed by a secondary decrease, and others showed continuous low levels with or without a further decrease. Panmyelophthisis was observed in 10 of 29 mice which survived for more than 20 weeks after the administration of 0.5 μC/g of ^{32}P 10 or 15 times. Peripheral blood counts in these mice took various courses, but mice which showed a prompt initial recovery to normal peripheral blood counts later developed marked anemia, leukopenia, and thrombocytopenia. In mice which survived for more than 20 weeks after ^{32}P administration, there were two with adenoma of the lung and one with osteogenic sarcoma among 19 mice given 0.5 μC/g of ^{32}P 10 times, and one each with osteogenic sarcoma and myelogenous leukemia out of 10 mice given 0.5 μC/g of ^{32}P 15 times. Neither neoplasms nor leukemia were observed in the mice given 4.0 μC/g of ^{32}P once or in the control mice. (BBB)

11019 LASER-INDUCED MICROVASCULAR THROMBOSIS, EMBOLIZATION, AND RECANALIZATION IN THE RAT. Kochen, Joseph A.; Baez, Silvio (Albert Einstein Coll. of Medicine, New York). Ann. N. Y. Acad. Sci., 122: 728-37(May 28, 1965).

The effect of a ruby laser beam (6943 Å) on the microcirculation of the rat mesoappendix was followed by cinephotomicrography. Single laser pulses of up to 7.5 mJ resulted in a progressive increase in vasomotion and vascular hyperreactivity, i.e., the concentration of epinephrine required to elicit a control response decreased progressively with increasing laser intensity. These changes were not associated with discernible morphologic vascular lesions or thrombus formation. However, the introduction of colloidal carbon into the blood stream immediately before lasing (0.5 to 3.8 ml) resulted in a progressive adherence of carbon granules to the inner surface of the vessel. Laser pulses of higher intensity (7.5 to 15 mJ) resulted in a transient sticking of platelets and leukocytes in the immediate area of lasing and the occurrence of a widespread and clearly demarcated region of increasing carbon accumulation. Deposition of carbon gradually extended from the inner endothelial surface of the vessel through the perivascular space to the basement membrane and perivascular sheath. Laser pulses of 15 to 30 mJ intensity resulted in maximally enhanced vasomotion, associated with formation of a mural thrombus at the site of injury. Focusing of a laser pulse of 30 mJ on the wall of an arteriole or venule resulted in the deposition of a fused red cell aggregate on the endothelial surface at the lasing site and the evolution of a gas bubble which rapidly disappeared. Platelets and leukocytes rapidly adhered to the red cell mass and the adjacent endothelial surface. The resulting cell mass rapidly increased in size, forming an extensive and stable thrombus. Single laser pulses of 30 to 60 mJ intensity frequently resulted in localized regions of complete vessel wall breakdown and the occurrence of varying degrees of interstitial hemorrhage. (BBB)

11020 IN VIVO EFFECTS OF LASER RADIATION ON THE SKIN OF THE SYRIAN HAMSTER. Fine, Samuel (Northeastern Univ., Boston); Klein, Edmund; Farber, Sidney; Scott, Ronald E.; Roy, Albert; Seed, Richard E. J. Invest. Dermatol., 40: 123-4(Jan. 1963).

Studies to determine the effects of laser radiation on skin were carried out with lasers employing rods of neodymium-doped glass capable of generating an output in excess of 70 J. Animals in the first group were irradiated with a single pulse of 30 J focussed onto areas of the external surface of the anterior abdominal wall. The immediate effects resembled those of a 2nd degree thermal burn with a mild erythematous areola. All animals recovered completely from the immediate effects of exposure to laser radiation. The gross appearances of the lesions in the skin on the 5th day postirradiation suggested a more severe reaction in the lighter colored areas than in darker regions. Microscopic examination revealed that fewer hair follicles were in the lighter areas than in the darker areas; coagulation necrosis had occurred; leukocytes had infiltrated between necrotic areas and viable tissue; and that epithelialization of the tissues was proceeding from the margin of the lesion. The animals in the second group were exposed to an output of 50 J. The immediate and subsequent effects appeared to be similar to those observed in the first group. One animal died within 5 hr of irradiation. Autopsy disclosed that a moderately severe reaction consisting of hemorrhage and edema had occurred and had extended through the anterior abdominal wall onto the peritoneal surface without apparent discontinuity of peritoneum. Subadjacent areas of the stomach and intestine showed distension. Subserosal hemorrhages and edema were present in the wall of the stomach; subepithelial hemorrhages also occurred in the intestinal wall. (BBB)

11021 ANASTOMOSIS FORMATION BETWEEN SPLEEN AND ABDOMINAL WALL FOLLOWING UV RADIATION IN THE RAT. Gruenagel, H. H.; Domres, B. (Univ., Freiburg i. B.). Z. Gesam. Exp. Med., 139: 506-12(1965). (In German).

The effect of uv radiation in causing hyperemia and collagen fiber degradation was investigated. The spleen and parietal peritoneum of male and female rats were exposed to intensive uv radiation (at laparotomy), to create adhesions. Then the spleen was fixed to the abdominal wall with two catgut sutures. The initial reactions to uv radiation were hyperemia, petechial hem-

orrhages, denaturation of the capsular collagen, and edema. After 6 days, capillaries from the splenic pulp and the abdominal wall were observed, penetrating the damaged splenic capsule. From the 14th to the 45th day (the end of the experiment) capillary anastomoses were found in all specimens. The histological findings were confirmed by radiology after injection of contrast medium into the spleen, and by plastoid casts of the anastomoses. The time course of these changes is described in detail. (BBB)

11022 BEHAVIORAL CHANGES IN AN ANT COLONY EXPOSED TO CHRONIC GAMMA IRRADIATION. Brower, John H. (Dept. of Agriculture, Savannah, Ga.). Amer. Midland Naturalist, 75: 530-4(Apr. 1966). (BNL-9049)

Changes in the behavior of a colony of ants, Formica integra, were investigated in an area experimentally exposed to chronic ^{137}Cs γ radiation at Brookhaven National Lab. The colony was exposed to 10.0 R/hr of γ radiation for 20 hr each day. Throughout the first half of the summer, after radiation damage was well developed in the plant community, the ant colony remained normal in appearance and behavior. Workers continued to bring both plant debris and insect food to the nest; although the latter appeared to be reduced in amount. In August, the colony was apparently in the process of establishing a secondary colony. The line of march was north and tangential to the circle of radiation damage and was lost among the forest-floor litter at about 60 m from the radiation source. In the spring of the second year the colony was found to be active with many ants foraging. The nest had short sunken runways radiating in several directions which were roofed with plant debris. In the third summer the colony seemed to have gained in numbers; however, the ants' behavior seemed unusual. A runway 12.5 m long had been constructed extending from the colony; the exposure level in it being only 3.3 R/hour or about one-third of that at the nest. The runway was excavated below the surface of the soil and was covered so that the level of radiation was lower in this runway than at the surface. The ants used this runway exclusively in travel to and from the nest. Changes in the community caused by radiation complicate the interpretation. With the death of vegetation, the herbivorous insects and their parasites and predators were eliminated. Another factor which could have been operative was the increase in exposure to sunlight because of the elimination of the tree canopy. The behavioral change most apt to have been caused by direct radiation-avoidance response was the abandonment of the litter-collecting habit. However, the complex behavioral patterns exhibited by ants make any conclusion as to causal factors for the observed changes purely speculative. (BBB)

11023 AUTOIMMUNE PROCESS IN ACUTE RADIATION SICKNESS AND THE INFLUENCE OF ANTIBIOTICS ON ITS DEVELOPMENT. Milman, M. Sh.; Nikolaev, I. A.; Temirgaliev, A. G. (Inst. of Roentgenology, Radiology, and Oncology, Tashkent). Byull. Eksp. Biol. Med., 12: No. 10, 38-41(Oct. 1966). (In Russian).

Material is presented on the formation of autoantibodies during irradiation of rabbits at a dose of 600 R and the influence of antibiotics (penicillin, streptomycin, oxytetracycline, levomycetin) on their titre. Methods are described for the detection of autoantibodies by means of sedimenting the antigen-antibody complex with subsequent nephelometry. Autoantibodies to the liver, spleen, kidney, lymphatic glands, aorta, heart, large and small intestine were determined. It has been found that in rabbits, on the second day after their exposure to ionizing radiation, autoantibodies form, whose titre increases with the progression of radiation sickness. Antibiotics inhibit the development of the autoimmune process. (auth)

11024 CHANGE IN SERUM PROTEINS IN RATS WITH RADIATION LESIONS. Kashkin, K, P.; Aleksandrova, S. V. (Inst. of Medical Radiology, Obninsk, USSR). Byull. Eksp. Biol. Med., 12: No. 10, 57-61(Oct. 1966). (In Russian).

Immunoelectrophoretic analysis of serum proteins in rats of the August strain irradiated with γ-rays in a dose of 630 R showed an increase in the hetrogeneity of B_2B- and B_3B-globulins with the appearance of electrophoretically faster or slower fractions retaining (B_3B) or slightly changing (B_2B) their antigenic properties. Beginning with the 7th day after irradiation the serum of irradiated animals is found to contain a new radiation antigen migrating during electrophoresis together with slow α_2-globulins and indicated by α_2x-protein. This protein fails to appear after irradiation of sera in vitro and is absent both in healthy and artificially infected nonirradiated animals. (auth)

11025 ACTIVITY OF THE ENZYMES ALKALINE DESOXYRIBONUCLEASES, GLUCOSE-6-PHOSPHATE DEHYDROGENASE, AND 6-PHOSPHO-GLUCONATE DEHYDROGENASE, IN THE PLASMA OF RATS IRRADIATED WITH SUBLETHAL AND LETHAL DOSES. Fantoni, A.; Botteghi, F. (Centro Applicazioni Militari Energia Nucleare, Pisa, Italy). Minerva Med., 56: 3866-8(Nov. 14, 1965). (In Italian).

The relation between the dose received and the plasma level of the activity of alkaline desoxyribonucleases was investigated on rats exposed to whole-body doses of 250, 500, and 1000 R x radiation. The results do not indicate a precise relation between the dose received and the enzymatic activity for either of the two enzymes considered. The marked difference in the behavior of G6PD and 6PGD leads to the interpretation that the increase of 6PGD is caused by a break of the cellular structure of the corpuscular fraction of the blood. (J.S.R.)

11026 SOME HEMATOPOIETIC VARIATIONS IN DIFFERENT SPECIES OF ANIMALS AFTER WHOLE-BODY IRRADIATION COMPARED WITH ANALOGOUS VARIATIONS IN MAN. Mazzella, G.; Blundo, G. Minerva Med., 56: 3918-21(Nov. 14, 1965). (In Italian).

The content of some blood constituents, determined by experimental studies on γ irradiated mice, rats, and guinea pigs, was compared with literature data on their content in irradiated dogs and monkeys and in humans accidentally exposed to high radiation doses. The effect of LD_{50} and LD_{100} doses of radiation on the hematocrit and number of white blood cells, reticulocytes, polynucleate cells, mononucleate cells, and bone marrow cells are shown graphically. (J.S.R.)

11027 EFFECTS OF X RADIATION ON THE IMMUNIZATION RESPONSE OF RABBITS INNOCULATED WITH LIVER CELLS OF MOUSE EMBRYOS IN CONTINUOUS CULTURE. Polese, M. M. E.; Rossi-Torelli, M.; Bragazzi, G. (Centro Applicazioni Militari Energia Nucleare, Pisa, Italy). Minerva Med., 56: 3929-32(Nov. 14, 1965). (In Italian).

The modifications induced by x rays in the immune response of rabbits innoculated with cultured mouse embryos liver cells were studied by comparing the response of irradiated and non-irradiated animals. The rabbits were exposed to doses of 400 and 600 R. Morphological examination of the cells showed that an irradiation of 600 R depressed the defense of the animal to the point that it was no longer capable of producing antibodies. Irradiation with 400 R did not cause a similar effect. (J.S.R.)

11028 FUNCTIONAL ACTIVITY OF LEUKOCYTES IN EXPERIMENTAL RADIATION SICKNESS. Almazov, V. A.; Broun, L. M.; Kuzmina, N. V. Radiobiologiya, 6: 700-3(1966). (In Russian).

The effects of external radiation on the functional indicators of leucocyte activity were studied using the osmotic stability of the leucocyte and their motive activity as the test signs. Rabbits were exposed to total doses of 300, 500, 700, 800, and 960 R and indicators were measured on different days after irradiation. The results obtained show the regular changes of the functional activity of the granulocytes of the peripheral blood of rabbits in radiation sickness. These changes are shown in the depression of the osmotic stability of the polynuclear cells during clinical-hematological picture of radiation sickness. The marked decrease of the activity of the mononuclear cells in the first days after irradiation shows the effects of radiation. The activity of granulocytes increases immediately after irradiation and then decreases. (J.S.R.)

11029 DYNAMICS OF VESSEL PERMEABILITY BY COMBINED INFLUENCE OF WHOLE-BODY γ IRRADIATION AND BURN. Stepanov, E. P. (Kharkov Medical Inst.). Radiobiologiya, 6: 756-8(1966). (In Russian).

The total vessel permeability and the permeability of vessel-tissue barriers of the liver, spleen, hip muscle, kidney, small intestine, heart, lung, eye, and vessels of the burned area were investigated after whole-body γ irradiation at 800 R in male rats with third degree burns covering 10% of the body. The results showed that the combined effects of irradiation and burns cause a significant increase of the total permeability of the vessels at 1 hr and 1, 3, 5, and 7 days after the trauma. The disturbance of the permeability of the barrier of the organs, compared with the effects of irradiation alone, started earlier and was expressed to a much greater degree. (J.S.R.)

11030 VASOPRESSOR ACTIVITY AND HISTOCHEMICAL CHARACTERISTICS OF THE POSTERIOR LOBE OF HYPOPHYSIS OF NORMAL AND IRRADIATED RATS. Bagramyan, E. R.; Babadzhanova, S. Yu. Radiobiologiya, 6: 758-9(1966). (In Russian).

The functional condition of the posterior lobe of the hypophysis in normal and irradiated rats was investigated. Simultaneously a study was made of the vasopressor activity of the neurohypophyseal extract and the histochemical picture of the posterior lobe. The rats were exposed to x-ray doses of 800 R under standard conditions. 5 to 8 days later the animals were decapitated and the functional condition of the posterior lobe was determined.

The introduction of homogenates of neurohypophyseal tissues of irradiated rats into other rats caused a sharp increase of the arterial pressure. The vasopressor effect of neurohypophyseal extract was compared with a dose of synthetic vasopressor in the neurohypophysis of normal rats. The vasopressor activity of some irradiated rats was much greater, although the majority did not vary from the normal. There was no significant difference from the normal in the histochemical picture of irradiated rats. (J.S.R.)

11031 X-RADIATION INFLUENCE ON NERVOUS ACTIVITY OF DOGS BY APPLYING VITAMIN COMPLEX. Shalnev, B. I. Radiobiologiya, 6: 760-3(1966). (In Russian).

Whole-body x irradiation of dogs at doses from 350 to 500 R leads to the development of radiation sickness of different degrees of gravity with significant disturbance of higher nervous activity in the form of a weakening of the processes of internal inhibition, decrease of the conditioned reflexes, and development of phase states. Prophylactic and medical treatment with complexes of the vitamins C, P, and B groups leads to a lessening of the functional disturbance of the cortex of the brain in the animals. (tr-auth)

11032 INFLUENCE OF DISTURBANCES OF OXIDATION AND PHOSPHORYLATION ON SENSITIVITY OF IRRADIATED ANIMALS TO MICROBE TOXIN. Kiselev, P. N.; Sivertseva, V. N. Radiobiologiya, 6: 763-5(1966). (In Russian).

The disturbance of the oxidation and phosphorylation processes during irradiation appears to be one of the possible reasons for the increase of the sensitivity of the irradiated animals to toxins. The introduction in to irradiated and non-irradiated animals of preparations disturbing the oxidation and phosphorylation and of reducing materials changes their sensitivity to toxins. The increase of the free oxidation does not change the resistance of irradiated animals to toxins in contrast to non-irradiated animals. Blockade of the thyroid gland with methylthiouracil decreases the sensitivity to endotoxins. The introduction into the organism of α-dinitrophenol, causing oxidation and phosphorylation, increases the resistance to endotoxins. Reducing substances (cysteine and cystamine) decreases the sensitivity of irradiated and non-irradiated animals to endotoxins. (tr-auth)

11033 IRRADIATION DAMAGE OF STOMACH INDUCED BY RADIOACTIVE CERIUM. Lebedeva, G. A. Radiobiologiya, 6: 697-9(1966). (In Russian).

On the introduction of radioactive cerium into the stomach, massive and comparatively brief irradiation of its walls occurs which leads to the development of inflammatory, distrophic, atrophic, and sclerotic changes as well as to the formation of tumor growths. The characteristics of the development of pathological processes in different sections of the stomach are determined by the character of their histological structure. The marked disturbances have a phase character and are clearly evident for a long time after the introduction of the isotope. (tr-auth)

11034 PROBLEM OF ESTIMATING RADIOSENSITIVITY OF WHITE RATS. Vasilev, G. A.; Belyaev, V. A.; Tiunov, L. A. Radiobiologiya, 6: 687-9(1966). (In Russian).

The individual differences in the consumption of oxygen at the moment of stress effects (chilling) in white rats can be correlated with their individual differences in radiosensitivity. (tr-auth)

11035 TELANGIECTASIA AS A REPAIR PHENOMENON IN RADIATION-INJURED SKIN. Wiskemann, A. (Univ., Hamburg). Bibl. Anat., 7: 491-5(1965). (In German).

Circulatory changes in skin as late effects of ionizing irradiation were investigated. Blood flow in skin which had become atrophic because of x-ray therapy was recorded by measuring the thermal conductivity of the skin with and without suppression of the blood supply. Three patients were examined who had received an overdose of x rays on one hand 10 to 20 years ago. After 10 min heating with infrared light the blood flow of the injured skin was greater than in the heated normal contralateral skin. This confirms earlier findings obtained using the ^{24}Na skin clearance method. Intact blood flow in the x-ray atrophic skin is regarded to be a sign of repair by development of telangiectasia. Thus the original radiation injury resulted in destruction of small blood vessels and concomitant fibrosis of the dermis. This atrophic process is apparently compensated for by dilatation of the surviving blood vessels in the subepidermis. This phenomenon was also demonstrated histologically by biopsies of skin in one of the 3 patients studied. (BBB)

11036 CLINICAL AND RADIOBIOLOGICAL CONSEQUENCES OF THERAPEUTIC THYROID IRRADIATION. Greig, W. R.; Crooks, J.; Macgregor, A. G. (Royal Infirmary, Glasgow). Proc. Roy. Soc. Med., 59: 599-602(July 1966).

Hazards of the use of ^{131}I to treat hyperthyroidism are reviewed. Multiple treatments are required in many patients before hyperthyroidism is controlled, and a rising incidence of postirradiation hypothyroidism has occurred. It is shown that multiple doses were necessary in 38% of 242 patients, and that the ultimate incidence of hypothyroidism was over 40%. After one year over 80% of patients were euthyroid and only about 10% hypothyroid, but when these patients were re-examined after periods ranging from two to eight years it was found that only 53% were euthyroid and the incidence of hypothyroidism had increased to 41%, an incidence independent of the number of doses given. Evidence for the transition from the euthyroid to the hypothyroid state can be found by irradiating the rat thyroid in vivo under controlled conditions. Irradiation (both x rays and ^{131}I) in increasing doses progressively impairs the capacity of thyroid cells to multiply. These effects appear to be irreversible. It is of considerable clinical importance that doses that fail to impair the function of the normal rat thyroid cell population, abolish the capacity of the cells to multiply. It is suggested that the human thyroid is more radiosensitive than the rat thyroid. Doses used in the treatment of thyrotoxicosis can be expected to produce severe impairment of the capacity of the thyroid cells to multiply. As a consequence the prevention of thyroid cell renewal may result in a shrinking cell population and the subsequent development of thyroid failure. The rate of loss of the thyroid cells in postirradiation remnants depends on the radiation dose, the rate of cell renewal (mitotic index) and the capacity of surviving cells to undergo compensatory hyperplasia. Hypothyroidism is therefore more likely in patients whose thyroid glands were uniformly irradiated (regular intrathyroidal distribution of ^{131}I) and less frequent in patients whose glands were nonuniformly irradiated (irregular intrathyroidal distribution of ^{131}I). The more frequent occurrence of hypothyroidism in diffuse goiters compared to nodular goiters is consistent with this concept. (BBB)

11037 RETINAL METABOLISM AND IONIZING RADIATION. I. MODIFICATIONS OF PROTEIN SYNTHESIS IN ELEMENTS OF CENTRIPETAL CONDUCTION. Maraini, G.; Franguelli, R.; Marcato, M.; Santori, M. (Univ., Parma, Italy). Ann. Ottalmol. Clin. Oculist., 91: 583-9(July 1965). (In Italian).

In view of the previously found high degree of variability in radiosensitivity of different types of retinal cells, a more detailed study was conducted on the radioresponse of the ganglionic and bipolar cells concerned with centripetal conduction of neural discharges in the retina. The effect of local doses of x radiation on protein metabolism in the cells of adult rat retina was studied by evaluating, with a high resolution radioautographic technique, the incorporation of leucine labeled with tritium. Low doses of x rays were used (200 and 500 R), which did not produce cytologic damage. While a single retinal dose of 200 R did not alter leucine uptake, a rapid and significant increase of its incorporation was detected after 500 R in the ganglion cells, in the inner plexiform and inner granular layer of the retina. This increase was noted within 1 hr and was maintained throughout the 24-hr course of the experiment. It reached 120% in the inner plexiform layer. This increased rate of protein synthesis probably does not result from increased permeability of the cell membranes caused by irradiation, as has been previously proposed, but an alternative explanation does not appear possible at this time. (BBB)

11038 RETINAL METABOLISM AND IONIZING RADIATIONS. II. MODIFICATIONS OF PROTEIN SYNTHESIS IN SENSORY ELEMENTS. Maraini, G.; Santori, M.; Marcato, M.; Franguelli, R. (Univ., Parma, Italy). Ann. Ottalmol. Clin. Oculist., 91: 590-7 (July 1965). (In Italian).

The differential radiosensitivity of various classes of retinal cells was studied using doses of radiation that do not cause cytologic changes. Thus, protein metabolism after a single dose of x radiation (200 and 500 R) was studied in vivo in rat retina by evaluating, at the cellular level, ^{3}H-leucine uptake by a high resolution radioautographic technique. A significant increase in leucine uptake was detected immediately after irradiation in the centripetal conducting cells; in the sensory elements, on the contrary, protein metabolism was depressed to about 50% of the control values in the first hour; the incorporation gradually returned to normal values within the sixth hr and after 24 hr was significantly increased. The 24-hr values in the rod cells was about 85% higher than the control value and that in the outer granules was about 58% higher. The results are briefly discussed in view of a possible relation between protein metabolism and radioresistance in the different retinal cells. The variability of metabolic changes in various cell types appears to exclude the previously proposed explanation of increased cell permeability. (BBB)

11039 RADIATION FACTORS IN CONGENITAL MALFORMATIONS. Ogborn, Richard E.; Qualfe, Merton A. (Veterans Administration Hospital, Omaha, Neb.). J.- Lancet, 86: 371-3(July 1966).

An evaluation of the effects of ionizing radiations on embryonic development is made on the basis of the analysis of sources of radiation, probabilities of interaction of radiation and embryo, the reaction itself, resultant effects, and preventive measures to reduce harmful effects. Sources are discussed in terms of natural or unavoidable, medical, industrial, military, and miscellaneous categories. A summary of known facts concerning the interaction of radiation and embryos reveals that the damaging effects of radiation are noted primarily on the nucleus and chromosomes. The fertilized cell is more sensitive than either gamete. The embryo is most radiosensitive in an early embryonic stage of development. Diagnostic radiology exposures may cause severe deficiencies in certain early stages of the central nervous system. Marked effects include such results as anencephaly, cerebral atrophy, mongolism, mental retardation, and cerebral palsy. Almost the complete spectrum of eye abnormalities, from anophthalmia to partial albinism, has been observed. Skeletal deformities include odontogenesis imperfecta, abnormal limbs and feet, congenital dislocation of hips, vaulted cranium, and universal reduction of the skeleton as a whole. Other systems are equally affected, with, for example, absence of kidney, degenerate gonads, congenital heart disease, and pituitary irregularities. The responsible physician can prevent congenital malformations by eliminating or drastically reducing exposure of the woman of childbearing age to radiation. (BBB)

11040 SPACE MEDICINE. Ruff, George E. (Univ. of Pennsylvania, Philadelphia). Med. Times, 93: 353-60(Apr. 1965).

Various types of nonionizing and ionizing radiations, as well as other adverse environmental factors, to be encountered in manned space flight are reviewed, with emphasis on protection of personnel against them. The most serious hazard arises from the geomagnetically trapped radiation that forms the Van Allen belts. Dose estimations within the two belts are discussed. During minimal sunspot activity, if a spacecraft traveled rapidly through both belts, an astronaut would receive a whole-body dose of about 10 rad. If the path of the vehicle is chosen to avoid the inner belt, the dose would be about 3 rad. (TSS)

11041 SENSITIVITY OF OOCYTES IN POSTNATAL RHESUS MONKEYS TO X IRRADIATION. Baker, T. G. (Univ. of Birmingham, Eng.). J. Reprod. Fertil., 12: 183-92(Aug. 1966).

The radiation response of oocytes at different stages of follicular maturation and the dose of x rays needed to eliminate 50% and 100% of the germ cells within 1 to 30 days of exposure were determined in rhesus monkeys (Macaca mulatta) subjected to 1000 to 12,000 R unilateral ovarian irradiation. The ovaries were removed at 6 hr to 4 weeks later, and the number of normal and atretic oocytes at each stage of follicular maturation were counted in every 40th section of both treated and control gonads. Doses of 4000 to 12,000 R induced cytoplasmic eosinophilia in oocytes, pyknosis in many granulosa cells, and destruction of most of the multilayered follicles. The changes became more marked as the postirradiation interval was extended. The number of primordial oocytes were unaffected by exposure to <3000 R; such oocytes were, however, almost totally eliminated 7 days after treatment with 12,000 R. The $LD_{50/30}$ for germ cells at this developmental stage is about 5000 R. Oocytes enveloped by more than one layer of granulosa cells were more radiosensitive, only a small proportion surviving for 4 days after exposure to 4000 R. Ovaries recovered 25 days following irradiation with 5000 to 12,000 R contained few multilayered follicles; most of the germ cells were atretic and the granulosa cells pyknotic. The primordial oocyte of the rhesus monkey is markedly resistant to radiation-induced cell death, and contrasts sharply with the primordial oocytes of other mammalian species. (BBB)

11042 FINE STRUCTURAL CHANGES AND LOCALIZATION OF PHOSPHATASES IN THE EPITHELIUM OF THE DUODENAL CRYPT OF X-IRRADIATED MICE. Hugon, J.; Borgers, M. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Histochemie, 6: 209-25(1966).

Fasting adult male mice of the BALB/C^+ strain, weighing 25 g, received whole-body irradiation of 1350 R of x rays, and were sacrificed from 30 min to 96 hr after irradiation. The following lesions were observed in the first hours after irradiation: mitochondrial enlargement and rupture of their membranes, multiplication of dense bodies, formation of numerous cytolysomes, and nuclear anomalies. From 24 hours after irradiation until the death of the animal at the 4th or 5th day, the cells degenerate; the enormous nuclei with big nucleoli lose chromatin, disruption of ergastoplasm, and decreases of ribosomes and lipid inclusions are observed; the cytoplasm is reduced to a thin layer between the lumen of the crypt, where only atrophied microvilli remain. In the study of acid phosphatase in the stem cells of control mice, the reaction product (lead phosphate) was mainly situated in dense bodies and in small vesicles surrounding the Golgi cisternae. Between 90 min and five hr after irradiation, during the appearance of the intracytoplasmic cytolysomes, changes occurred in the cytochemical localization of the enzyme. The Golgi zone emits numerous small vesicles loaded with reaction product; these structures seem to fuse into lysosome-like bodies. Afterwards, they are clustered in the cytolysomes in which 5 hr after irradiation, the lead phosphate precipitate is dispersed. The Golgi area in the cytoplasm shows decrease of enzymatic activity. After the elaboration of many vesicles containing lead phosphate precipitate and their dispersion during the first postirradiation day, the amount of cytochemically detectable acid phosphatase decreased and was nearly absent at the end of the fifth day. (BBB)

11043 CARCINOSARCOMA OF THE BODY OF THE UTERUS APPEARING SIX YEARS AFTER RADIATION TREATMENT OF CANCER IN THE CERVIX OF THE UTERUS. Bokhman, Ya. V.; Taveri, S. M. Akusherstvo Ginekol., 40: 155(Sept.–Oct. 1964). (In Russian).

At gynecologic examination a tumor was discovered in the uterine cervix of a 53-yr-old patient who had had 2 normal children and 7 miscarriages. The disease was diagnosed as cervical cancer, and intracavitary and external radiation therapy was used. Six applications of ^{60}Co were given, 5103 mg/hr for a total of 10,181 R. The tumor disappeared. The patient experienced 6 years of good health and was examined every 6 months by both an oncologist and gynecologist. During a vaginal examination at the end of 6 years an occlusive lesion of the upper vagina was discovered and a tumor was noted. Upon excision of the tumor and its extensions, a large submucosal nodule of soft consistency with areas of hemorrhage and necrosis was discovered in the cavity of the uterus. The postoperative period passed without complications and the patient recovered. The effects of previous therapeutic irradiation appeared to be a major factor in the origin of the tumor. (BBB)

11044 TOOTH DWARFISM AND ROOT UNDERDEVELOPMENT FOLLOWING IRRADIATION. Pietrokovski, Jaim; Menczel, Jacob (Hebrew Univ., Jerusalem). Oral Surg., Oral Med., Oral Pathol., 22: 95-9(July 1966).

Irradiation of the head and neck at an early age may interfere with the normal growth, development, and eruption of teeth. Depending on the tooth's developmental stage, irradiation injury results in varied manifestations that range from complete absence of the tooth to dwarfism of either tooth or root. The case of an 18-yr-old patient who had received irradiation beginning at the age of 2 to 2½ years is reported. Radiotherapy resulted in hypopituitarism, with signs of hypothyroidism. The teeth that failed to develop were the 4 third molars, both second mandibular molars, and the mandibular and maxillary left second premolars. Also noted were tooth dwarfism (maxillary second molars and right second premolar), root dwarfism (maxillary first molars, first premolars, canines, and incisors), and root shortening (both mandibular first premolars). The site of irradiation and the age at which each dose was administered explain both the distribution and the degree of damage to the developing teeth. Conservative dental treatment of the mandibular teeth was followed by insertion of a complete upper denture immediately after extraction of all 13 maxillary teeth. (TSS)

11045 SOME EFFECTS OF OPERANT CONDITIONING OF IONIZING RADIATION TO THE WHOLE-HEAD. Brown, W. Lynn; Blodgett, H. C.; Henderson, Donald; Ritter, R. M.; Pizzuto; Joseph S. (Univ. of Texas, Austin). J. Genet. Psychol., 108: 253-61(June 1966).

The effects of whole-head x irradiation on appetitional and avoidance response rates in rats were examined. In the first experiment, 26 Sprague-Dawley rats were trained in a Skinner box to work for food pellets. At asymptote they were divided into matched groups, then exposed to sham treatment or 1000, 2000, 4000, or 8000 R of x irradiation at 300 R/min. One hr after exposure the performance of irradiated rats was depressed in general relation to dose received. This was followed by a two-day recovery after which terminal depression occurred. In the second experiment, 25 rats were trained to avoid shock in a modified Skinner box, then were divided equally into 5 matched groups and irradiated. The ability of the rats to avoid shocks declined as a function of the dose. Thus head exposure at these doses produced a marked depression in performance that appeared to be dose related. The fact that the effect was seen one hr after exposure suggests a central nervous system effect rather than a gastrointestinal one. (BBB)

11046 CANCER OF THE LUNG: THE CYTOLOGY OF SPUTUM PRIOR TO THE DEVELOPMENT OF CARCINOMA. Saccomanno, Geno (St. Mary's Hospital, Grand Junction, Colo.); Saunders, Richard P.; Archer, Victor E.; Auerbach, Oscar; Kuschner, Marvin; Beckler, Patricia A. Acta Cytol., 9: 413-23(Nov.–Dec. 1965).

Nine cases of uranium miners with cancer of the lung are presented. Sputum specimens from these patients taken periodically

for up to 7 yr prior to their development of malignancy revealed varying degrees of metaplasia. The atypia of these metaplastic cells seemed to become progressively more marked as the malignancy developed. The final type of tumor that developed in these cases simulated the cellular architecture of the metaplastic cells. A scheme of classification of the metaplastic cells is suggested that is based on progression from Stage I to Stage II to Stage III of Class II metaplasia. It is concluded that Class II, Stage III metaplasia is the last step before malignancy. Thus, sputum cytology should be an excellent tool for screening populations with a high risk of lung cancer, such as uranium miners, chromate workers, elderly heavy cigarette smokers, or persons with suspected lung disease. Persons who are found to have Class II, Stage III sputum should be advised to stop all potentially carcinogenic exposures and be kept under medical surveillance. If this stage of metaplasia is reversible, such action might prevent the development of bronchogenic carcinoma, if it is not reversible, the procedure would facilitate early detection of malignancy. (BBB)

11047 PSEUDOMONAS AERUGINOSA INFECTION IN RATS USED IN RADIOBIOLOGY RESEARCH. Hightower, Dan; Uhrig, Henry T.; Davis, John I. (Walter Reed Army Inst. of Research, Washington, D. C.). Lab. Anim. Care, 16: 85-92(Apr. 1966).

In view of the known deleterious effects of Pseudomonas aeruginosa on the survival and survival time response of animals to irradiation, experiments were conducted to determine: the effect of P. aeruginosa on the response of rats to irradiation; the preferred method of screening rats for the presence of P. aeruginosa prior to irradiation; and the efficacy of water chlorination in controlling the spread of P. aeruginosa infection in a rat colony. Female, WRCF strain rats, 8 to 11 weeks of age, were used. The ^{60}Co γ radiation doses ranged from 750 to 1000 R at a rate of 100 R/min. In 83% of the animals (68 of 82) dying within 12 days after irradiation P. aeruginosa could be cultured from their spleens, while only 6.7% of the animals (3 of 45) dying in the next 18 days were similarly positive. Positive spleen and intestine cultures were obtained from only 9% of the surviving animals sacrificed, in marked contrast to 56% positive from the animals dying following irradiation. The source of the fulminating bacteremia from P. aeruginosa following irradiation appeared to be the throat and tracheal region. Cultures obtained from spleen and intestine of unirradiated animals did not yield information on the true incidence of infection, but spleen cultures from lethally irradiated animals did yield useful information of the true incidence of infection. The preferred screening method for detecting P. aeruginosa infection in a rat colony was by culturing drinking tubes. This was indicated by the fact that only rarely were positive cultures obtained from the mouth and throat or rectum without positive drinking tubes, but the same was not true for the reverse situation. In addition, the validity of screening by culturing drinking tubes was established by the experiment on radiation mortality. P. aeruginosa could be cultured from only 2 of 42 animals (4.8%) that was declared free of the infection on the basis of this screening method. On the other hand, the organism was found in 23 of 42 of those (55%) that were considered infected. The use of chlorinated water in the rat colony where indigenous P. aeruginosa infection was present appeared helpful in the prevention or deterrence of spread of the infection between animals in the same cage through the drinking apparatus. On the other hand, data obtained in another study involving irradiated rats indicated a high incidence of P. aeruginosa infection in animals that were on chlorinated water for 6 weeks. (BBB)

11048 LASERS, MIRACULOUS POLYVALENT INSTRUMENTS. Baeyon, Noeel. Gaz. Med. France, 72: 4165-70(Dec. 10, 1965). (In French).

Development of lasers, their mode of operation, and their applications, particularly in biological and medical research, are reviewed. Effects on animal and human tissues are described. Use of lasers in ophthalmology for photocoagulation of the retina, replacing other less efficient light sources, is also mentioned. (TSS)

11049 PRELIMINARY REPORT ON A SPINDLE-CELL SARCOMA IN THE SYRIAN HAMSTER PRODUCED BY THOROTRAST. Mori, Takesaburo; Sakai, Toshiharu; Okamoto, Takashi; Tamura, Nobuo; Nozue, Yushin; Ishida, Tadeshi; Umeda, Makoto (Yokohama City Univ., Japan). Gann, 57: 431-3(Aug. 1966).

Carcinogenicity of Thorotrast in the Syrian hamster was demonstrated. Spindle-cell sarcoma, probably of fibroblastic origin, developed in the cheek pouch submucosa of hamsters after a single dose of Thorotrast. Twenty mature hamsters, divided into four equal groups, were given 0.1, 0.2, 0.4, or 0.6 ml of Thorotrast into the submucosal soft tissue of the left cheek pouch. In 8 out of 14 animals of the 4 experimental groups that survived over 250 days, spindle-cell sarcomas developed at the site of the Thorotrast administration. None of the 20 animals of the control group that survived over 250 days developed tumors. There was no relation between the dose of Thorotrast injected and the incidence of tumors. The period between Thorotrast administration and macroscopic recognition of tumor formation ranged between 270 and 472 days. The tumors were macroscopically well-demarcated, about the size of a walnut, and elastic in consistency. On the cut surface, they were white-gray with a yellowish central zone of necrosis. X-rays revealed dot-like opacities in the tumors corresponding to the Thorotrast granules deposited in them. Microscopically the tumors consisted of interwoven bundles of spindle cells having ovoid or round nuclei with abundant chromatin, and projecting cytoplasm stainable by various collagen and reticulin staining methods. In many tumor cells and stromal cells ingested Thorotrast granules were present in cytoplasm. In 3 out of the 5 tumor-bearing animals closely examined, tumor metastases were found in the lung, liver, kidney, and lymph nodes. Homologous transplantation of the tumors was successfully made into the submucosal tissue of the cheek pouch, subcutis of the abdomen, peritoneal cavity, or hematogenously via the vein. Transplantation was successful in 100% of the cases. The tissue culture of the ascites tumor cells in the ascites form was successful. Two kinds of cells, spindle-shaped and multinucleated giant cells, grew in standard medium. Abnormality of the chromosome number was observed but there was no evidence suggestive of virus origin of the cells. (BBB)

11050 TOXIC HEMOPHATHIES. Piquet, H. Clinique (Paris), 59: 459-66(Sept. 1964). (In French).

Diseases of the hematopoietic system caused by ionizing radiations and other physical, chemical, and biological agents are reviewed. The incidence of such diseases is increasing as a result of increasing use of radiation and radioisotopes. Severe sequelae in the blood-forming tissues of such irradiation consist of aplastic anemia and leukemia. Aplastic anemia, which has an invariably fatal course, is rarely observed when irradiation is properly delivered. Leukemia is probably a more frequent result of irradiation, as evidenced by an incidence of ~5% in radiologists. Myeloid leukemia is the most frequent type in response to irradiation, and, contrary to some opinion, acute leukemia is also prevalent from this cause. Minor hematologic effects of radiation treatment are anemia and changes in leukocyte levels (either leukopenia or leukocytosis). It is necessary to stop radiotherapy when hematologic parameters reach certain limits, such as leukopenia of 3000 to 4000 cells/mm^3 or leukocytosis of >10,000 cells/mm^3. Persistent leukocytosis should be observed carefully for the possibility of it representing an early stage of leukemia. (BBB)

11051 RESPONSE OF TRIBOLIUM CONFUSUM TO RADIATIONS AND OTHER STRESSES. Ducoff, H. S.; Bosma, Gayle C. (Univ. of Illinois, Urbana). pp 83 of Proceedings of XVI International Congress of Zoology, Washington, D. C., August 20-7, 1963. Vol. 2

Studies on the acute lethal responses of x-irradiated Tribolium adults indicate that the midlethal dose (MLD) range is 6 to 12 kR. Investigations reveal a MLD for larvae of 2.5 to 5 kR. X irradiation of larvae leads to two other effects, a delay in pupation and, when very late larval stages are irradiated, morphological abnormalities in the resulting adults. First-day pupae are about as sensitive as larvae, but by the third day, pupae are as resistant as adults. Eggs are more sensitive than larvae, and the sensitivity of the egg is an inverse function of its age: 2 kR causes 100% lethality in eggs less than 24 hr old. In addition, sublethal irradiation of eggs markedly inhibits the subsequent rate of growth and development. X-ray effects on eggs and on pupae are mimicked by uv radiation; however, larvae appear less sensitive than adults to the stress of high oxygen pressure. (BBB)

11052 ON THE PREVENTABILITY OF RADIATION EFFECTS IN THE EFFERENT URINARY SYSTEM AND INTESTINE DURING RADIUM THERAPY. Johannssen, Horst (Univ., Goettingen, Ger.). Landarzt, 41: 149-53(Feb. 10, 1965). (In German).

Dose variations that resulted in 441 cases from the uncertainty of anatomical differences and dose measurement are described, where the intestinal and bladder irradiation ranged from 1000 to 6000 R. Most of the values observed were between 1000 and 3000 R. Using a different configuration of implant in 395 patients wide differences were observed in the amounts of irradiation to the intestine and bladder. In ~70% of the cases the rectal exposure was less than 2000 R, but this dose was received by the bladder in only 48% of the cases. A third configuration reduced the bladder irradiation to ~2000 R in ~87% of the cases, but in ~45% of the cases the rectal dose was greater than 2000 R. Similar variations were observed for Ra implant treatment of cervical carcinomas. The unavoidably high irradiation doses lead to a number of complications, ranging from inflammation to ulceration or fistula formation, or ureteral stenoses. (TSS)

11053 SCHWANN GLIAL ELEMENTS IN THE CHANGES OF NEUROMUSCULAR JUNCTIONS. Polikarpova, G. A.; Svatko, L. G.; Shmeleva, G. N. (Medical Inst., Kasan, USSR). Acta Morphol., Acad. Sci. Hung., 12: 379-86(1964).

Silver impregnation with phase microscopy was used to study the neuromuscular junction in persons exposed to radiation and suffering with various diseases, and in cats with experimental radiation injury. Changes could clearly be observed in the neurofibrillar component and the Schwann glial elements of the ending. The glial nucleoplasm was characterized by the presence of small, dark nuclei of oval shape, and showed conspicuous changes, especially in the altered motor nerve endings. First a swelling of the glioplasm takes place and the number of the Schwann nuclei increases; at the same time the nuclei begin to situate themselves in a cone at the border of the motor end-plate. In the nerve endings showing progressive changes of the neurofibrillar apparatus, with an increase of the axon terminal, a further growth with structural changes of the glial part takes place. Parallel with the growth of the neurofibrillar mass and its transformation into a terminal neuroma, a considerable increase of the glial component occurs which is transformed into a massive nucleoplasm body of syncytial structure. All parts of the neuroma seem to be embedded in glial protoplasm. The changes of the sarcoplasmic part of the nerve ending are less marked. In the early stages of the reactive changes, the size of the nuclei increases significantly. Subsequently they disappear and only Schwann cell nuclei can usually be observed in the substance of the neuroma. The sarcoplasm of the intensively changed nerve endings has a granular character. (BBB)

11054 INFLUENCES ON THE PATTERNS OF SPERM PRODUCTION IN SWINE FOLLOWING X-IRRADIATION. Cox, D. F.; Willham, R. L. (Iowa State Univ., Ames). J. Exp. Zool., 146: 5-10(Feb. 1961).

Duroc and Hampshire boars were irradiated, when they were 6 months of age, by a single x-ray exposure (300 to 900 R) directed locally to the testicles. The irradiated animals were submitted to semen collections 3 times a week, once a week, or twice a month. The results showed an interruption in the recovery pattern by a second postirradiation decline in sperm number. The pattern was most evident in the boars treated with 600 R. The animals exposed to 900 R showed only slight recovery from exposure to 200 days. Further collections on these animals $1\frac{1}{2}$ years after exposure indicated that even then they had only reached 18% of the control sperm count. The animals exposed at 300 R showed some evidence of a second decline but not as clearly as those exposed to 600 R. The total sperm per collection in boars treated with 600 R reached the first min 60 to 70 days from exposure. In the second decline around 140 to 160 days the counts reached levels comparable to those in the first low period. Values indicated that environmental trends were not responsible. A reduction in the number of days from x-ray exposure to min sperm counts by more frequent collections was seen, and is probably the result of more rapid depletion in the number of stored sperm. (BBB)

11055 THE ETIOLOGY OF LEUKEMIA: SOME COMMENTS ON CURRENT STUDIES. Nowell, Peter C. (Univ. of Pennsylvania, Philadelphia); Hungerford, David A. Seminars Hematol., 3: 114-21(Apr. 1966).

Evidence relating to the leukemogenic action of ionizing radiation, as well as of chemical agents and viruses, is reviewed. Results of animal studies are also discussed. (TSS)

11056 ASSESSMENT OF RADIOSENSITIVITY OF CARCINOMA OF THE CERVIX. Dubrauszky, V. (Univ., Wuerzburg, Ger.). J. Obstet. Gynaecol. Brit. Commonwealth, 73: 41-3(Feb. 1966).

A method was devised for assessing the response of carcinoma of the cervix to a test dose of radiation. To obtain a homogenous group, 100 patients were studied who had squamous-cell stage III carcinoma of the cervix to be treated solely by radiotherapy. Following initial biopsy the patients were given a test dose of 250-kv x radiation (800 R) on two occasions at an interval of 24 hr. A further biopsy was taken 8 days after the test dose of radiation, and the following cell changes noted histologically: marked swelling of the cells, loss of definition of the cell and nuclear outline, vacuolization of the cytoplasm and the nucleus, granules in the cytoplasm and nucleus, the presence and number of granulated giant cells, abnormalities of cell division, and shrinking and necrosis of cells. The radiosensitivity of the tumors was classified as follows: high radiosensitivity, when the percentage of degenerate cells after the test dose of irradiation was between 66 and 100%; moderate radiosensitivity, when the percentage lay between 33 and 65%; and low radiosensitivity, when the percentage was between 1 and 32%. In the 68 tumors available for assessment, 13% were highly radiosensitive. Although the cases were only followed-up for two years, so far a correlation exists between the histological evaluation of the tumor radiosensitivity and the clinical results. In tumors of low radiosensitivity 49% of the patients were cured or improved, compared with 69% in those with tumors of moderate radiosensitivity, and 100% in those of high sensitivity. Despite the small number of patients, these differences are statistically significant. (BBB)

11057 THE TRANSITION FROM POLYCYTHEMIA VERA TO OTHER MYELOPROLIFERATIVE SYNDROMES ON THE BASIS OF THE AUTHOR'S CASES. Lawkowicz, Wlodzimierz; Czarnobielska, Wiktoria; Traczyk, Zdzislawa (Inst. of Hematology, Warsaw). Pol. Arch. Med. Wewn., 34: No. 7, 961-5(1964). (In Polish).

Three cases are described of polycythemia vera which show the sequence of phases in a myeloproliferative process possibly associated with the x-ray therapy the patients received. In one case, 10 yrs after the diagnosis of polycythemia was established, a transition was noted to osteomyelosclerosis with almost total atresia of bone marrow spaces. In the other two cases the myeloproliferative process was observed to develop in three phases: from polycythemia vera through a well-marked phase of osteomyelosclerosis to acute leukemia. In both cases radiotherapy had been instituted in the early course of the disease. In one of these patients the symptoms of leukemia occurred four years after the diagnosis of polycythemia was established and radiotherapy instituted, while in the other patient leukemic symptoms appeared 17 years after the diagnosis of polycythemia and 8 years after x irradiation. In two cases bone lesions typical of osteomyelosclerosis were associated with a periosteal reaction. In the third case these changes were due to leukemic infiltration, which was confirmed by microscopic examination. (BBB)

11058 THYROID NODULES AS A LATE SEQUELA OF RADIOACTIVE FALLOUT IN A MARSHALL ISLAND POPULATION EXPOSED IN 1954. Conard, R. A. (Brookhaven National Lab., Upton, N. Y.); Rall, J. E.; Sutow, W. W. New Eng. J. Med., 274: 1392-9(June 23, 1966).

This report concerns the recent development of thyroid abnormalities among the 82 people of Rongelap Atoll who received the largest accidental exposure to fallout radiation in 1954. The accident was the result of an unpredicted shift in winds after the experimental detonation of a large thermonuclear device at Bikini in the Marshall Islands. Pathologic changes in the thyroid gland were found in some people of Rongelap Island. Definite thyroid nodules were noted in 11 people, minimal changes in 5 others, and hypothyroidism in 2. All but 1 case occurred in the more heavily exposed population (55 living of the original 64 persons), who received about 175 rad of whole-body γ radiation, burns of the skin from fallout products, and internal absorption of fission products. One case with a nodule was noted among 16 adult women who had received less than half the exposure of the other group. In 200 controls, no such thyroid abnormalities were found. In the more heavily exposed group, thyroid abnormalities developed in 55% of children exposed at less than ten years of age. Five children were found at surgery to have benign adenomatous goiters. One adult patient had a mixed papillary and follicular carcinoma, with localized metastasis. Two boys showed marked retardation of growth, apparently owing to primary hypothyroidism. The radiation etiology in these cases appears certain. The thyroid glands received a substantial dose of radiation from radioiodines and external γ radiation (adults about 300 rad, and children about 700 to 1400 rad). These findings suggest that the seriousness of the internal hazard associated with fallout, particularly from radioiodine, must be revised upward. The observed high incidence of thyroid abnormality emphasizes the caution with which radiation must be used clinically, particularly in children. (BBB)

11059 EFFECT OF X-RAYS ON THE COURSE OF EXPERIMENTAL MYOCARDITIS IN WHITE RATS. Samsonow, M. A. (Inst. of Rheumatology, Moscow). Reumatologia (Warsaw), 1: 169-87(1963). (In Polish).

In view of the known beneficial effects of low-dose (100-R) x irradiation on rheumatic heart disease and inflammatory joint disease in man, radiation studies were conducted on a model myocarditis in animals. Myocarditis was induced in rats by subcutaneous injection of 10^8 β-hemolytic streptococci (group A, type 27) along with adrenaline. Some rats were given precardial x rays over a 2×2 cm field in four doses of 25 R every fourth day (total of 100 R). The course of the myocarditis was followed by electrocardiograms and by histopathologic examination. Typical electrocardiographic changes were seen in the nonirradiated controls as evidence of severe streptococcal myocarditis, confirmed microscopically. Infiltration of myocardial connective tissue by lymphocytes and histiocytes, with degeneration of muscle fibers, was seen. The course of myocarditis was milder and its resolution quicker in rats which received 100-R irradiation of the heart. (BBB)

11060 PROLIFERATIVE ABILITY OF X IRRADIATED BONE MARROW FROM DONORS OF DIFFERENT AGES. Koukalova, Blazena; Karpfel, Z. (Inst. of Biophysics, Brno). Folia Biol. (Prague), 12: 283-9(1966).

The proliferative ability of bone marrow taken from donors of different ages (1 to 27 weeks) and subjected to x irradiation in vitro was studied in mice. Evaluation was based on proliferation

of intravenously administered bone marrow cells in the spleen of preirradiated recipients. The cell-survival curves, the slope of which reflected the D_0 value, were used for evaluation of the decrease in proliferative ability after x irradiation. It was found that the D_0 values calculated for the exponential part of the curves fell as the age of the donors rose. Generally, larger radiation doses were required to lower the proliferative ability in young bone marrow than in older bone marrow. The incidence of spontaneous postmetaphasic chromosomal aberrations in the bone marrow were also determined in four donor age groups. It was found that the incidence increased with the age of the animals. The results are discussed. (auth)

11061 EXPERIMENTAL STUDIES ON ALLOTRANSPLANTATION IMMUNITY. APPEARANCE OF RED CELL INCOMPLETE ANTIBODIES AFTER ALLOTRANSPLANTATION AND SUPPRESSIVE EFFECT OF WHOLE BODY X-RAY IRRADIATION ON THE ANTIBODY FORMATION. Kaneda, Takeshi (Osaka City Univ.). Osaka Shiritsu Daigaku Igaku Zasshi, 15: 253-75(June 1966). (In Japanese).

It was shown that allografted animals produced humoral antibodies, including incomplete antibodies against red cells. The present experimental results showed that hemolytic anemia due to incomplete antibodies was frequently encountered in rabbits following allogenic skin grafts and simultaneous injection of large doses of rabbit spleen cells. X irradiation was not necessary for the development of incomplete antibodies. These incomplete antibodies were absorbed by donor spleen, skin, liver, or lymph node extracts, but not by recipient spleen or skin extracts. It was concluded that the development of incomplete antibodies did not require the persistence of allografted tissue or infused cells, but the stimulation of recipient antibody forming tissue with a substance or substances contained in infused cells or allografted tissue. (89 references.) (auth)

11062 AGE PECULIARITIES OF PERIPHERAL NERVE TRUNK PATHOMORPHOLOGY FOLLOWING X IRRADIATION. Akhmedov, N. K. (Tashkent State Univ.). Uz. Biol. Zh., No. 4, 72(1966). (In Russian).

Experiments with 36 mature and 20 young rabbits locally irradiated at the back surface of the left hip with x rays of 300 R (6 min. 30 sec.) for 4 days exhibited destructive effect on young rabbits after 5 days and in mature rabbits after 7 days following the exposure. Regenerative processes in the damaged nerve fibers were observed in young rabbits 10 to 14 days and in mature 14 to 20 days following the irradiation of the sciatic nerve. Intensive growth of fine nerve fibers in the fibular and tibial nerve began in the young animals about 19 to 20 days following irradiation and 30 to 35 days in the old ones. A secondary wave of degenerative processes of young axons in the sciatic, tibial, and fibular nerves was observed in young rabbits on the 60th to 90th day and in old rabbits on the 40th to 45th day after irradiation. (R.V.J.)

11063 BLOOD COAGULATION AND FIBRINOLYSIS IN PATIENTS WITH CANCER OF THE CERVIX UTERI FOLLOWING RADIATION TREATMENT. Musyatovich, Yu.; Gulyanovska, E.; Skshidlevski, Z.; Vrublevski, M. Med. Radiol., 11: No. 12, 10-14(Dec. 1966). (In Russian).

Subject to investigation were blood coagulating system and fibrinolysis after beam therapy in 96 patients for cervical cancer in stages II and III. In the group with the II stage of the tumor, blood coagulation was found to remain elevated both before and after the treatment, along with intensified fibrinolysis. In the III stage weakened retractability of the blood clot was revealed. The thrombocyte count in both groups of patients following beam-treatment was reduced. The blood circulation and coagulation time remained within normal limits. (auth)

11064 COMPLEX DEVELOPMENTAL MALFORMATIONS IN A CHILD AFTER X-RAY EXAMINATION DURING PREGNANCY. Szentendrei, L.; Kurusa, Emma; Szederkenyi, Gy. (County Council Hospital, Kecskemet, Hung.). Acta Morphol. Acad. Sci. Hung., Suppl. 13: 43(1965).

A retarded female child born with clubfoot and treated for chronic pyelonephritis died with renal failure. Autopsy revealed hydrocephalus due to agenesis of the aqueduct and an ectopic kidney. History revealed that the mother had been submitted to gastric x ray examinations in the 2nd and 3rd weeks of pregnancy. From the amount of radiation received by the mother and a comparison of this with the amount giving rise to similar malformations in animals it is concluded that the defects observed in the child had probably been caused by the x rays. (BBB)

11065 INFLUENCE OF RADIUM THERAPY ON INTRAOCULAR PRESSURE IN HYPOPHYSEAL TUMORS. Slavin, L. G.; Mamin, R. G. Med. Radiol., 11: No. 12, 7-10(Dec. 1966). (In Russian).

Intraocular tension was measured in patients given radium therapy for hypophyseal adenomas. A gradual decrease in intraocular pressure to normal values was observed in patients with pathological conditions, and a decline to below-normal values was found in patients normal in respect to intraocular pressure. (H.G.D.)

11066 STUDIES ON THE BONE IMPAIRMENT BY THE DEEP RADIOTHERAPY FOR CANCER OF THE UTERUS, ESPECIALLY ON THE NECK OF FEMUR. Nakano, Mitsuto; Obuchi, Tatsuro (Kyushu Univ., Fukuoka). Fukuoka Igaku Zasshi, 52: 586-93(Aug. 1961). (In Japanese).

Clinical symptoms of pathologic fracture of the neck of the femur, caused as a side effect of telecobalt therapy for cancer of the uterus, were examined in 11 cases. Such radioinduced pathologic fracture ranges from 0.7 and 3.2% in incidence according to various reports. The age of the patients studied was ~60 yr. Most of the patients who were treated with ^{60}Co, when ordered to walk within 3 years of the treatment, i.e., during the latent period of the fracture, complained of a neuralgic pain arising and spreading from the lumbogluteal region and increasing in severity. Most patients were unaware of fracture's development. In most cases the femur in such patients showed an x-ray picture in which the bone had a wedge-shaped or lateral area of mineral absorption above the neck. The treatment of this bone impairment may be either of conservative or surgical nature. For both, early discovery and early treatment are indispensable if it is to be effectively cured. The condition is handled by orthopedic treatment in most cases. The final diagnosis of these fractures should be determined histologically. A slice of bone tissue should be obtained from the affected bone when definitive surgical steps are taken. However, biopsy cannot readily be undertaken merely for the purpose of clinical diagnosis. (BBB)

11067 EFFECTS OF RADIATION ON THE GROWTH OF EUGLENA CELLS. Matsuoka, Saburo (Gifu Prefectural Medical School, Japan). Bull. Inst. Chem. Res. Kyoto Univ., 42: 1-9(Jan. 1964).

Euglena gracilis var. bacillaris cells were irradiated in distilled water by γ-ray doses of 1 to 3×10^5 R, for 30 to 90 min, and by neutron doses of 4.1×10^7 to 5.4×10^{12} n/cm^2, for 10 to 90 min. No apparent difference was observed between the effects of γ rays and neutrons on the growth of the cells. Many cells survived these irradiation doses, but marked effects were observed on their growth. The albino mutation rate of the irradiated cells was in proportion to the irradiation dose. Cells immediately after irradiation and their progeny over several generations reached the stationary phase of the culture at 10 to 25% lower cell concentrations than the nonirradiated cells. For a lethal dose, $LD_{50/12}$, Euglena cells required about $2 \times 3 \times 10^5$ R of γ rays and about 3.6×10^{12} n/cm^2 of neutrons. Rapidly growing cells were generally more radioresistant than the cells of stationary cultures. Several generations after both irradiations, a slight difference of cell size was observed between irradiated and nonirradiated cells. Albino mutants of the cells were readily induced by γ and neutron irradiation. (BBB)

11068 STUDIES ON RADIATION INJURIES. REPORT 7. MORTALITY, BODY WEIGHT, AND WOUND HEALING IN NMRI MICE, FOLLOWING TREATMENT WITH WHOLE-BODY RADIATION IN COMBINATION WITH OPEN SKIN WOUNDS. Messerschmidt, Otfried; Birkenmayer, Eline; Koslowski, Leo (Univ., Freiburg i. B.). Strahlentherapie, 131: 423-44(Nov. 1966). (In German).

Present results obtained with male and female NMRI mice confirm the results which were obtained previously in another mouse strain: mice with open skin wounds show a high mortality if these wounds are inflicted after a whole body irradiation with 510 R ($LD_{21/30}$). The radiation mortality was not increased or even decreased if the wound was inflicted prior to the irradiation. The combination damage shows characteristic weight curves, depending upon the succession of irradiation and wound infliction or the time intervals between both traumas. In case of high mortality, the weight losses are very high, up to 30% of the initial weight. The healing of the wounds is clearly delayed in animals which have received the wounds prior to irradiation. Possible explanations for the results obtained are discussed. (auth)

11069 SURGICAL APPLICATIONS OF LASER. McGuff, Paul E.; Deterling, Ralph A. Jr.; Gottlieb, Leonard S.; Fahimi, H. Darriush; Bushnell, David (Tufts-New England Medical Center, Boston). Ann. Surg., 160: 765-77(Oct. 1964).

Effect of laser radiation on animal and human tumors was studied. Twenty different types of malignant tumors were treated in over 700 Syrian hamsters. Ruby lasers (0.5 to 360 J) with simple optical systems for focusing the beams were used. The beam was emitted for 0.5 to 3 msec. Energy density at the tumor varied from 17 to 12,000 J/cm^2. The range of laser energy required to destroy tumors was from 60 to 545 J per tumor. The

wide range of laser energy necessary for destruction was explained by the fact that each tumor consisted of multiple smaller tumors and each required a 130 J laser burst for eventual regression. The average laser energy required was 255 J per tumor. Temperature measurements within the tumor at the time of laser energy action were made by four different systems. Temperatures within the lased tumors probably did not exceed 46°C one sec after the laser burst. The thermal decay time of a tumor treated with a laser energy burst was six to 12 times slower than the thermal decay time of a tumor treated with a red-hot cautery. A discussion on the effectiveness and usefulness of lasers as a tool for radiotherapy of neoplasms was presented. (BBB)

11070 EFFECT OF THE LASER BEAM ON THE SKIN: PRELIMINARY REPORT. Goldman, Leon; Blaney, Donald J.; Kindel, Dan J. Jr.; Franke, Earnest K. (Univ. of Cincinnati). J. Invest. Dermatol., 40: 121-2(Jan. 1963).

Experiments were conducted with a ruby laser providing an output of 5 J, at 6943 Å. When eyes of anesthetized rabbits with pupils dilated were exposed to the laser beam, no evident damage was produced in the eyes of albino rabbits. In the eyes of black rabbits, exposed to this same beam, severe and immediate eye damage resulted. Extensive retinal hemorrhage, retinal perforation, and exposure of the sclera were observed. Albino and colored rabbit skin and skin from Caucasian and Negro volunteers were exposed to the laser beam under the same conditions. Microscopic examination of white skin and white hairs of the rabbits showed no changes. Black hairs showed charred areas with no evident change in the white skin underneath. Pigmented skin of the rabbit ear had small, deep, charred areas. Inflammatory reaction was evident in the tissues about the necrotic zone of the laser reaction. In the Negro skin, slight pricking was felt and a small area (1.0 × 1.5 mm) of white superficial scaling was observed at the site of impact of the laser beam. Tissue destruction was superficial. There was an inflammatory cellular response. Sulfhydryl stains revealed no changes in keratin that was adjacent to the impact area. The impact area was represented by a superficial ulcer. No lesions could be detected under similar conditions of exposure on Caucasian skin. In an effort to increase the absorption of the laser beam, white skin was covered with lampblack. The reaction was more intense, a puff of smoke was often observed at the impact area, and superficial burns were produced in the skin of Caucasian patients. Light colors may reflect or transmit the beam without causing any evident change. (BBB)

11071 VARIATION IN SURVIVAL TIME OF MICE RECEIVING X-IRRADIATED MURINE LYMPHOMA CELLS. Maruyama, Y. (Stanford Univ., Palo Alto, Calif.). Brit. J. Radiol., 39: 740-3(Oct. 1966).

The survival times of normal isologous recipient mice were studied following the inoculation of x-irradiated murine ascites lymphoma cells. Host survival times were prolonged with increasing x-ray dose when irradiated tumor cells were inoculated, and an oxygen effect was observed. Death of the host animals is attributed to those tumor cells in the irradiated population that retain reproductive integrity and multiply to a lethal cell number. (auth)

11072 CONSIDERATION OF THE BIOLOGICAL EFFECTS OF LASERS. McCartney, Alan J. (Army Medical Research Lab., Fort Knox, Ky.). Military Med., 130: 1069-77(Nov. 1965).

Physical properties of laser radiation from the different types of lasers are described and an attempt is made to correlate these properties with observed biological effects. The biological and lethal effects of laser radiation are described in detail with regard to radioinduced injuries in intact animals, animal and primate eyes, animal and human skin, and malignant tumors of animals and man. Within the present state of the technology, laser radiation is not known to represent a lethal hazard to man; however, laser radiation has inflicted severe damage to unprotected human eyes and safety precautions should be observed in regard to this hazard. (TSS)

11073 RADIOAUTOGRAPHIC PROCESSING SEQUENCE FOR COVERSLIP MONOLAYER TISSUE CULTURES LABELLED WITH TRITIATED THYMIDINE. Drown, C. W. R.; Greenham, L. W.; Hill, T. J.; Meek E. S.; Peacock, D. B. (Medical School, Bristol, Eng.). Lab. Pract., 16: 49-59(Jan. 1967).

Studies are in progress on the nuclear damage to cells following irradiation with ultraviolet light of 2537 Å wavelength. The damage is in part measured by the ability of the irradiated cells to incorporate tritiated thymidine into the nuclei, and in part by the intensity of the superimposed Feulgen staining reaction. Coverslip monolayer cultures of the cells proved to be eminently suitable for these studies because numbers of replicate cultures were easily and quickly processed at any one time, and because permanent preparations were readily made of the finished radioautograms for microscopic and reference purposes. The coverslips measured 25 × 7 mm in order to fit within tissue culture tubes for the initial preparation of the monolayers. Their small size required the development of appropriate processing techniques, and the radioautographic sequence described was found to be adequate for the nuclear studies in progress. (UK)

11074 INCREASED SENSITIVITY OF MAMMALIAN CELL CULTURES TO RADIOMIMETIC ALKYLATING AGENTS FOLLOWING INCORPORATION OF 5-BROMODEOXYURIDINE INTO CELLULAR DNA. Schindler, Richard; Ramseier, Luise; Grieder, Alfons (Swiss Inst. for Experimental Cancer Research, Lausanne). Biochem. Pharmacol., 15: 2013-23(Dec. 1966).

Cultures in vitro of a murine mast cell tumor were incubated with 5-bromodeoxyuridine in order to incorporate 5-bromouracil into cellular DNA. Cells containing 5-bromouracil in their DNA exhibited an increased sensitivity to two biological alkylating agents, mechlorethamine (nitrogen mustard, HN2) and dimethylmyleran. This increase in sensitivity, however, was lower than the corresponding increase in radiosensitivity. Sensitivity to increased incubation temperatures was not significantly changed by the pretreatment of cultures with 5-bromodeoxyuridine. It is concluded that DNA represents the primary target for the action of these alkylating agents on cell reproduction. The results obtained suggest, however, that the chemical alterations of DNA caused by mechlorethamine, dimethylmyleran, and x rays may be different. (auth)

11075 ANTIBODY FORMATION IN IRRADIATED RATS. Simic, Miroslav M.; Sljivic, Vojin S.; Petrovic, Milica Z.; Cirkovic, Dimitrije M. Bull. Boris Kidrich Inst. Nucl. Sci., 16: (Suppl. 1), 1-151(Dec. 1965).

Methods used in investigations of the effects of whole-body exposure to γ or x radiation on humoral antibody synthesis in rats are described and results are reported from measurements of antibody response to agglutinin and hemolysin in nonirradiated rats. Factors modifying antibody formation during whole-body irradiation or local spleen irradiation, and factors promoting protection and recovery of the immune capacity in irradiated rats are discussed. Studies on the hemolysin response in rats treated with MEA or AET shortly before exposure to 250 or 550 R x radiation showed that these compounds protected the antibody-forming capacity. Homologous spleen DNA, administered after x irradiation at the two dose levels, produced a partial restoration of the hemolysin response in rats. (160 references.) (C.H.)

11076 DEVELOPMENT OF IMMUNOLOGICALLY COMPETENT CELLS IN THE RAT. Goldschneider, Irving; McGregor, Douglas D. (Western Reserve Univ., Cleveland). Nature, 212: 1433-5(Dec. 24, 1966).

Normal newborn F_1 hybrid rats were inoculated with parental bone marrow cells, parental thymocytes, or thoracic duct cells obtained from inoculated animals. Female rats (60-80 g body weight) that were recipients of first-set skin grafts or nonrecipients of skin grafts were exposed to 300 R x irradiation 9 days and/or 24 hr prior to injection. The survival rates of the treated rats provided strong evidence that the small lymphocytes in these inocula were immunologically competent and could bring about a graft-versus-host reaction. Evidence presented also strengthened the view that immunologically inactive cells in bone marrow and thymus proliferated or matured in the primary F_1 host; however, evidence that thoracic duct cells were capable of proliferating in the primary host was not obtained. Information as to the origin or state at which small lymphocytes, or possibly their precursors, acquire the capacity to initiate an immunological response was not given. (B.H.S.)

11077 INH ABSORPTION IN THE DIGESTIVE TRACT OF IRRADIATED RABBITS. Grossmann, V. (Charles Univ., Hradec Kralove, Czechoslovakia). Cesk. Fysiol., 15: 422-3 (Sept. 1966). (In Czech).

In experiments on rabbits that were irradiated with a dose of 1000 R it was determined that absorption in the digestive tract was reduced beginning with the 3rd day after irradiation. (JPRS)

11078 RADIATION NECROSIS OF THE JAW. Cupar, Ivo; Barlovic, Mladen (Univ., Zagreb). Radovi Med. Fak. Zagrebu, 13: 195-203(1965). (In Croatian.)

A narrative report is given of experience with 15 patients, all treated with radiation for neoplastic disease of organs of the maxillofacial area, who had a side reaction in the form of radiation necrosis of the jaw. The incidence of this adverse effect is stated to be 5 to 24%; the diagnostic and therapeutic difficulties are outlined and discussed. (JPRS)

11079 AN ELECTRON MICROSCOPE STUDY OF VITALLY STAINED SINGLE CELLS IRRADIATED WITH A RUBY LASER MICROBEAM. Storb, Rainer; Amy, Robert L.; Wertz, Richard

K.; Fauconnier, Bernard; Bessis, Marcel (Centre National de Transfusion Sanguine, Paris). J. Cell Biol., 31: 11-29(Oct. 1966).

An electron microscope study was made of vitally stained single cells in which the cytoplasm was subjected to a localized ruby laser microbeam. Light and moderate laser absorption (the resultant of stain concentration and laser energy density) produced restricted selective damage of mitochondria in cells stained with Janus green B; heavy laser absorption resulted in mitochondrial damage, as well as in nonselective interaction with other cell structures. With four other basic vital stains, the polysomes, ergastoplasm, mitochondria and other organelles at the irradiated site were uniformly damaged. Unstained cells showed no morphological alterations. With light primary damage (that restricted to the irradiation site), no secondary effects of the incident radiation were observed. With moderate primary damage, however, secondary damage of the mitochondria in the unirradiated cell portions was produced, which was reversible within 4 hr after irradiation. Heavy primary lesions caused severe secondary alteration of all cell structures that was irreversible and cell death occurred within 2 hr. Surviving cells examined 24 hr after light and moderate irradiation could not be distinguished from unirradiated controls. The possible mechanisms involved in the production of laser-induced cellular alterations are discussed. (auth)

11080 EFFECT OF X RAYS ON HUMAN STERNAL MARROW CIRCULATION. Trubowitz, Sidney; Strauss, Herbert; Small, Maurice J. (Veterans Administration Hospital, East Orange, N. J.). Radiology, 88: 140-1(Jan. 1967).

The effects of x-rays on the sternal marrow blood flow were evaluated in 15 patients by the half-time clearance of locally deposited ^{131}I Hippuran. Fourteen of the 15 patients had received a calculated dose in excess of 3,000 R to the sternal area. The mean $T^1/_2$ clearance was 28 ± 17.3 seconds, a statistically significant value. The data do suggest some impairment of marrow circulation following irradiation; however, this disturbance in marrow flow is probably not the prime factor in failure of marrow regeneration. (auth)

11081 CHANGES IN THE NUMBER OF MOUSE THYROTROPES FOLLOWING RADIOTHYROIDECTOMY. Messier, Bernard (Institut du Cancer, Montreal). Acta Endocrinol., 52: 391-8(July 1966).

A quantitative analysis was made of the variations which take place in the number of thyrotropin (TSH)-secreting cells (thyrotropes) following radiothyroidectomy in female LAF_1 mice. Radiothyroidectomy was performed by injecting intraperitoneally 200 μC carrier-free ^{131}I in each mouse. The effect of radiothyroidectomy on the number of alcian blue-positive cells in pituitary was tested in groups of 20 mice injected with ^{131}I and sacrificed after 5, 10, 20, and 30 days. In comparison to the 0.87% frequency of alcian blue-positive cells found in normal mice, a significant reduction to 0.50% was noted as early as five days after injection of ^{131}I. This numerical reduction was also accompanied by a weakening of the strain intensity in the remaining alcian blue-positive cells. Ten days after radiothyroidectomy, the frequency and intensity of alcian blue-positive cells was back to normal value (0.85% ± 0.32). Subsequently, at 20 and 30 days, this value dropped to 0.20 ± 0.04 and 0.11% ± 0.09 respectively, with a further reduction of straining intensity. Administration of thyroxine was prompt in restoring alcianophilia to pituitary glands of radiothyroidectomized mice. As soon as two days of treatment the average per cent of alcian blue-positive cells was 3.59%. Since no mitoses were found to account for the increased number of thyrotropes, it is likely that radiothyroidectomy mobilized other existing pituitary cells, possibly chromoprobes. Thus, the frequency of thyrotropes drops after radiothyroidectomy and also after feeding thyroxine to intact mice. But the mechanism is different in each case. In the former, absence of thyroxine creates a higher demand on TSH and leads to an emptying of alcianophilic material from the thyrotropes. In the latter, thyroxine excess leads to repression of TSH synthesis. (BBB)

11082 EFFECT OF HIGH ENERGY LASER PULSES ON THE PRIMATE LIVER. Mullins, Fitzhugh; Minton, John P.; Hoye, Robert C.; Dearman, James R.; McKnight, William B. (National Cancer Inst., Bethesda, Md.). Surg. Gynecol. Obstet., 122: 727-32(Apr. 1966).

Preliminary to the application of laser energy for the destruction of multiple human liver metastases, an evaluation of the pathophysiologic effects of laser energy on the liver of monkeys was performed. Twelve healthy rhesus monkeys (Macaca mulatta) underwent celiotomy 1, 3, and 6 weeks after laser impact for gross and histologic evaluation of the liver damage. The laser consisted of a neodymium glass rod excited by an FT-79 xenon flash lamp. The total energy delivered to the surface of the liver ranged from a low of 3436 to a max of 29,350 J. All animals survived the acute effect of the experiments. One week after laser impact yellow granular gross lesions with punched-out central crater defects were present. At 3 weeks and 6 weeks postirradiation, the lesions were progressively diminished in size. Thin, fibrinous adhesions were present between the anterior abdominal wall and the liver. The liver over the lased area was covered by a thick fibrous scar. Six weeks after exposure of the liver to laser radiation, proliferation of capillaries and partial replacement of the areas of necrosis by active fibroplasia were noted. Serum glutamic-oxalacetic transaminase levels rose immediately after laser impact to over 3 times the prelaser value in all animals. Serum glutamic-pyruvic transaminase changes paralleled these changes, and lactic dehydrogenase values were profoundly altered following laser radiation of the primate liver. Elevations, often reaching as high as 4000 units after multiple high-energy laser impacts of the liver, are interpreted as the result of red blood cell destruction in this vascular organ as well as hepatic cell injury per se. (BBB)

11083 RADICAL NECK DISSECTION FOR THORIUM DIOXIDE GRANULOMA: CASE REPORT. Chalat, Ned I.; Zane, Alan I. (Harper Hospital, Detroit). Arch. Otolaryngol., 83: 610-14(June 1966).

The history of thorium dioxide as a diagnostic medium in radiology is discussed, the complications and symptomatology relative to its use are reported, and the literature relative to the oncogenic effects of this substance is reviewed. The third case of thorium dioxide granuloma of the neck treated by radical neck dissection is presented. A 61-yr-old man who had been injected with Thorotrast 12 yr earlier during carotid arteriography developed hoarseness and a neck mass which prompted biopsy followed by a diagnosis of laryngeal carcinoma with metastases. Further radiologic evaluation by means of percutaneous angiography established the apparent preoperative occlusion of the carotid vessels. Excision of the carotid on the involved side was without serious sequelae. The postoperative cranial nerve and sympathetic palsies were tolerated well, and were no worse than those produced by the expanding lesion itself. From x-ray examination after extensive neck dissection, it was apparent that complete and total removal of thorium dioxide-involved structures was not accomplished. Residual deposits of thorium dioxide were also present postoperatively in the two previously reported cases treated by radical neck dissection. Surgery reduced the total area under radioactive exposure, but did not completely eradicate the carcinogenic potential of this substance. In as much as even small quantities of thorium dioxide are considered carcinogenic, the question arises as to the value, if any, of surgery when complete excision is not considered feasible. However, it appears that excision of all feasible carcinogenic substance is mandatory to prevent concentration of the material in the liver and spleen, since these organs are particularly susceptible to neoplastic change. Until a statistically significant quantity of patients with this condition are operated on, results evaluated, and research conducted, the problem of complete removal and carcinogenic potential will remain unanswered. (BBB)

11084 CASE REPORT OF LIVER CANCER INDUCED BY THROTRAST AND A STUDY OF THE METABOLISM OF DAUGHTER NUCLIDES. Ogawara, Shigeyuki (Nagasaki Univ. School of Medicine). Nagasaki Igakkai Zasshi, 40: 169-75(Feb. 1965). (In Japanese).

The literature relating to Thorotrast deposition in the liver and its carcinogenic effect is reviewed. Experiments in mice on ThO_2 tissue distribution are reported preliminary to presentation of data on a patient with hepatic cancer due to ThO_2 deposits. In mice injected with 0.5 ml Thorotrast, the liver concentration of the Th rose sharply from the first 10 days but by the 20th day had become stabilized and no further increase in Th deposition was noted. An autopsy report is presented on a 56-year-old Japanese male who died of liver cancer induced by Thorotrast injected during angiography 29 years ago. A radiometric study of the liver was done, and the metabolism and excretion of daughter nuclides were investigated. The results showed that a large proportion of daughter nuclides produced from Th was eliminated from ThO_2-infiltrated organs. About 79% of the daughter nuclides was removed from the liver, after disintegration of Th. However, the Thorotrast deposited in the liver was excreted in only very small amounts. It is concluded that the carcinogenesis is closely related with the deposition of Thorotrast. Autoradiograms are illustrated, demonstrating α-particle tracks in the patient's liver tissue. (BBB)

11085 EXPERIMENTAL RESEARCH ON RETINAL COAGULATION BY MEANS OF THE LASER. Francois, J.; Hanssens, M. (Univ., Ghent). Bull. Soc. Belge Ophthalmol., 139: 317-23(1965). (In French).

Experiments were conducted in rabbits on the effect of laser radiation on the eye. The M-10 ruby laser emitting 6943-Å light at 0.01 to 0.25 J was used. The lesions produced in the rabbit

retina by various energies are described as seen ophthalmoscopically and histologically. At relatively low energies, the coagulation site appeared homogeneously bleached, with small hemorrhages. By the third day the lesions became slightly pigmented. Histologically, two types of lesions were seen. In the first type the pigment epithelium, cones, and rods are destroyed and surrounded by an eosinophilic exudate, but the choroid is normal. In the second type, a choroid-retinal adhesion is present. Compared with other photocoagulators, the laser gives a more circumscribed lesion in the retina, and the lesion becomes pigmented more rapidly after coagulation, that is, in two to three days compared with about one week with other coagulators. The lesion produced by the laser is stabilized within ~ one week, contrasted to three weeks with other photocoagulators. The vitreous is usually unaffected by the laser beam except for a bubble appearing at higher energies. (BBB)

11086 EXPECTED DEATH RATES OF ATOMIC BOMB SURVIVORS IN HIROSHIMA PREFECTURE. Watanabe, Mineo (Hiroshima Univ.). Nippon Eiseigaku Zasshi, 18: 366-70(Dec. 1963). (In Japanese).

Problems encountered in estimating and evaluating the significance of death rates in the Hiroshima survivors on the basis of records of the Atomic Bomb Casualty Commission (ABCC) are discussed. It is suggested that the registration data of death and disease for atomic bomb survivors are not adequate at the present time. Research workers have been depending on limited data to study statistical aspects of atomic bomb survivors and sometimes the samples studied did not adequately represent the atomic bomb survivors. Calculations were made of the expected death rates of atomic bomb survivors in Hiroshima Prefecture by using death rates by sex and age of all Japan, Hiroshima Prefecture, and the medical records from ABCC. The population of atomic bomb survivors over 15 years was taken from the National Census in Hiroshima Prefecture 1960. Death rates for all Japan and Hiroshima Prefecture over a 15-yr period were obtained up to 1960. Mortality rates in the medical records of ABCC extended from October 1950 to June 1958. In the comparison between expected death rates of atomic bomb survivors and actual death rates for all Japan or Hiroshima Prefecture over the 15-yr period, the former rates were always higher than the latter in males, females, and both sexes. The expected death rate of male atomic bomb survivors showed the highest discrepancy from the actual death rate of all-Japan males over 15 years, being 60% higher than in the latter. Some medical records of the ABCC, i.e., the ST-100 sample, seemed to inadequately represent the atomic bomb survivors mortality rates in Hiroshima Prefecture, it is suggested. (BBB)

11087 MARINE ISOPODS FROM HIGHLY RADIOACTIVE PLACES. Silva, Jayme de Loyola e (Univ., Parana, Brazil). An. Acad. Brasil. Cien., 37: Suppl., 259(1965).

Some results of a World Health Organization-sponsored survey of biological effects of natural radiation on man are reported, that were conducted in Brazil under the auspices of the National Committee for Nuclear Energy. Parallel studies were also made on plants and animals from areas with abnormal radiation levels. On the assumption that higher concentration of natural radioactivity in certain places might cause a higher rate of mutations in certain organisms, studies were performed on some plants and animals at Guarapari, a highly radioactive zone. These were also aimed at determining the effects of radioactivity on survival and possible evolutionary implications. On the beaches of Guarapari collections were made on two different substrata: plants and mesopsammal. In the mesopsammal, formed from coarse sand, only one species was found: Microcerberus delamarei. The plant substratum is formed by the following algae adhering to rocks partially submerged in the zone under wave action: Jaenia sp., Cladophora fascicularis, Halimeda sp., Ulva fasciata, Zonaria sp., Sargassum cymosus, and Padina sp. On these algae the following animals were found: Leptochelia sp. (Tanaidacea); Cymodoce barrerae, Cymodocella guaroparíensis (new sp.), and Asellus attenuatus. On the beach of Guarapari the radiation level varied from place to place and levels of 0.4–2.0 mR/hr were recorded. The algae themselves are radioactive. The isopods ingest monazite particles together with their food and are thus in constant contact with radiogenic elements. The isopods from the mesopsammal receive the greatest radiation exposure because they are in intimate contact with radioactive materials and this may cause a high rate of mutation. However, these preliminary studies do not yet permit unequivocal conclusions; therefore, it is suggested that an intensive survey be made, as well as a biometric study of these species, to compare them with those from other Brazilian beaches where radioactivity is much lower. (BBB)

11088 CHANGES IN FIBRINOLYTIC SYSTEM IN X-RAY-TREATED CHILDREN WITH NEOPLASTIC DISEASES. Berger, Magdalena; Zaorska, Barbara (Research Inst. of Mother and Child Care, Warsaw). Pol. Med. Sci. Hist. Bull., 9: 86-8(Apr. 1966).

Changes in the fibrinolytic system were followed in 30 children with neoplastic diseases in relation to the clinical course and x-ray treatment. The results showed distinct although variable influences of neoplastic diseases on the fibrinolytic system. With children in advanced stages of a neoplastic disease, considerable activation of fibrinolytic activity was noted. Some correlation between the progress of the neoplastic process and the behavior of the fibrinolytic system was found. The influence of x-ray treatment on fibrinolytic activity seemed to be less marked. In children with a rapidly advancing neoplastic process, in spite of treatment, continued increase of fibrinolytic activity occurred. Some effect of therapy on the fibrinolytic activity was seen, thus, lower fibrinolytic activity was found after treatment with x rays than in healthy children. Earlier reports indicated that the increase of fibrinolytic activity seen in neoplastic disease in children treated with x rays was due to increased disintegration of cells and liberation of cellular activators. The present results, however, are contradictory because at the period of temporary amelioration of the general condition of the treated children, no increase in fibrinolytic activity was observed. It is possible that an increased fibrinolysis in neoplastic disease was one of the causes of the development of dysproteinemia. (BBB)

11089 RADIATION INJURIES DUE TO RADIUM COMPRESSES. Born, Willi (Albert-Ludwigs Univ., Freiburg i. B.). Z. Haut. Geschlechtskrankh., 39: 57-65(July 15, 1965). (In German).

For treatment of pain a 42-yr-old man applied a Ra compress daily for 6 yr to the neck and to the kidney and bladder areas. The compress contained ~ 0.2 mg of Ra and was applied to the neck area regularly for ~ 12 hr/day and to the other areas for ~ 8 hr/day. The Ra was contained in a flat plastic bag. As a result of the chronic exposure to radiation, skin injuries appeared, first of all on the neck and 2 yr later on the lower back field. These consisted of exophytic squamous cell carcinomas. It was not possible to ascertain the total radiation dose received at any of the skin-compress interfaces. However, when compared to other reports of similar cases the latent period which amounted to 6 yr seemed to be relatively short. This suggested that the total radiation dose received may have amounted to several thousand R. Considering how well known the effects of radiation are to the medical profession, it should be emphasized that there is a requirement for expert medical supervision in every instance where radiation is used, in order to avoid such injuries as reported here. (BBB)

11090 THE ROLE OF ATTENUATED CERCARIAE IN EFFECTIVE IMMUNIZATION AGAINST SCHISTOSOMA MANSONI. Perlowagora-Szumlewicz, Alina (Instituto Nacional de Endemias Rurais, Rio de Janeiro). Rev. Brasil. Malariol. Doencas Trop., 16: 505-25(Oct.-Dec. 1964). (In Portuguese).

Although the course of normal infection with schistosomas can be slightly changed by a previous exposure to irradiated cercariae, specific acquired resistance to schistosomiasis is not acquired. Factors responsible for failure to develop protective immunity may have been due to the relatively small numbers of cercariae and excessively high radiation doses which prevented the establishment of the antigen in the experimental animal. Therefore, further experiments in which mice were exposed to relatively large numbers (1500) of cercariae irradiated with 2000 R were performed. The development of irradiated cercariae in the host and response to a challenge infection were followed. Results indicated that while the relative worm yield was low, the absolute worm yield from 1500 cercariae irradiated with 2000 R outnumbered that from 70 normal cercariae used in challenging the mice. Worms that developed from irradiated cercariae were present continuously in the host during the 210 days of observation. While male worms outnumbered females in the population from normal cercariae, the contrary was found in populations from cercariae exposed to radiation, thus decreasing significantly the male/female ratio. Egg-laying capacity of the worms was impaired as evidenced by low egg recovery from the liver. The aborted infection with irradiated cercariae did not interfere with the course of a challenge infection. Moreover, the liver-egg accumulation in animals challenged after exposure to 1500 irradiated cercariae frequently exceeded that in control mice. The sterilizing effect of radiation on cercariae of known sex was studied by determining the liver-egg accumulation in mice exposed to irradiation single sex cercariae prior to challenge with normal cercariae of the heterologous sex. Both female and male worms developing from irradiated cercariae were capable of laying eggs when in contact with normal worms developing from a challenge infection. Generally, the male/female ratio in populations from irradiated cercariae was found to be below unity while that in population from normal cercariae was above unity, suggesting a higher sensitivity of male

than female cercariae to radiation damage. Mice preinfected with irradiated (2000-R) male cercariae showed a somewhat lower mortality than control mice, but even the max difference of 19.2% occurring at 19 weeks was nonsignificant. By contrast, exposure to female cercariae irradiated with 2000 R produced a certain degree of resistance which permitted mice to live longer following the challenge infection with 70 mixed cercariae. The max difference of 31.4% in cumulative mortalities among mice preinfected with irradiated female cercariae, as compared with the controls, occurred at 23 weeks and was significant. Some damage to the reproductive capability of worms evidently resulted from preinfection with irradiated female cercariae. (BBB)

11091 THE EFFECT OF INTERNAL IRRADIATION BY ^{32}P UPON TUBERCULOSIS IMMUNITY WITH BCG AND IN VIVO MULTIPLICATION OF TUBERCLE BACILLI. Toyohara, Mareichi (Tuberculosis Inst., Tokyo). Igaku To Seibutsugaku, 70: 11-14 (Jan. 1965). (In Japanese).

The effect of internal irradiation by ^{32}P on the infectivity of tubercle bacilli and tuberculosis immunity by BCG was studied in CF1 male mice. The in vivo multiplication of virulent (H37Rv) tubercle bacilli after internal irradiation seemed to be increased; however, no statistical difference was observed. No significant difference in the experimental and control groups was demonstrated in the immunity conferred by BCG after the internal irradiation with ^{32}P. (BBB)

11092 THE EFFECTS OF CALCIUM, AGMATINE, AND PHOSPHATE ON MITOSIS IN NORMAL AND IRRADIATED POPULATIONS OF RAT THYMOCYTES. Whitfield, J. F.; Youdale, T. (National Research Council, Ottawa). Exp. Cell Res., 43: 602-10 (Oct. 1966).

Increasing the concentration of calcium in a simple glucose–salts medium increased the rate of entry of normal and γ or x irradiated (50 R) rat thymocytes into mitosis and their accumulation at metaphase. The rate of accumulation of cells in metaphase in both normal and irradiated thymocyte suspensions was also markedly increased by the polyamine agmatine; the optimal acceleration was produced by 2.5 mM agmatine, while progress of cells through mitosis was blocked by colchicine. Substitution of increasing amounts of phosphate for chloride in the medium did not reduce mitosis in unirradiated cell suspensions until the phosphate concentration exceeded 10 mM. However, irradiated cells were much more sensitive to changes in the phosphate concentration and phosphate concentrations between 5.0 and 20.0 mM strongly reduced mitosis. It is proposed that calcium and agmatine accelerate mitosis by promoting chromosome coiling while phosphate reduced mitosis by causing uncoiling, or disaggregation, of chromosomes. (auth)

11093 HYPOTHYROIDISM AFTER ^{131}I THERAPY. J. Iowa Med. Soc., 54: 600-2(Oct. 1964).

Hazards of radioiodine treatment of Graves' disease are considered, especially that of hypothyroidism as experienced in a large series of patients. After ^{131}I therapy, the incidence of hypothyroidism rose steadily to reach 29% after 10 years. Patients treated before the present method of determining the dose came into use became hypothyroid in 40% of cases after 11 or 12 years. Subsequently, all patients were treated by a standard method, and in that group a linear rise in the incidence of hypothyroidism was apparent. This result contrasted markedly with the findings in patients who had been treated by subtotal thyroidectomy. Several factors besides time appear to increase the likelihood of hypothyroidism after ^{131}I therapy. The incidence is greater in patients who have had partial thyroidectomies and then have had ^{131}I therapy following a recurrence of the disease. It is also greater in patients with small thyroid glands. In the first of these groups, the incidence was 21% between one and four years after treatment, and it then rose to 42% in the period from eight to 12 years after therapy. The incidence of hypothyroidism is consistently less in patients under 40 years of age. This difference probably was not due to age per se, but rather to the fact that younger patients usually had smaller glands. It is postulated that successful ^{131}I treatment results in a gross histologic derangement of the gland, so that its capacity to respond to stimulus is greatly reduced. Radioiodine is now used as the primary form of treatment for most patients with thyrotoxicosis. Initially, it was employed cautiously because of radiation hazards, but experience has shown that cancer and leukemia do not develop, and that genetic damage does not occur. Though originally restricted to the treatment of patients over 40 years of age, it is now employed in patients over 25 years of age. Between 100,000 and 200,000 patients have received ^{131}I therapy, and only two possibly malignant tumors have been reported. The real danger of ^{131}I therapy is in the development of hypothyroidism. (BBB)

11094 CILIATED CELLS IN THE SPLEEN OF ADULT RATS. Abdel-Bari, Waguih; Sorenson, George D. (Washington Univ., St. Louis). Anat. Rec., 152: 481-6(Aug. 1965).

During a study of the effects of 600-R whole-body x irradiation on male adult Sprague-Dawley rats, rare cilia were noted on reticular cells of normal and x-irradiated spleen. Each is composed of a cilium which appears continuous with a basal body, and is associated with a centriole lying free in the cytoplasm proximal to the base of cilium and usually at an angle with the cilium. The lining membrane of the cilium is continuous with the plasma membrane of the cell and invaginates into the cytoplasm along the shaft of the cilium to the level of the junction between basal body and cilium. The cilia might have diverse functions such as chemoreception, initiation of mitosis, or their presence might indicate metaplasia of the centriole, or reversion of the cell to a more primitive developmental state. They possibly may represent embryological remnants without function. (BBB)

11095 DYNAMICS OF RADIOCALCIUM IN THE HEART OF THE IRRADIATED ANIMAL. Voicu, V.; Muresan, V.; Nicolau, Elena. Rev. Sanit. Mil., 62: 299-301(Mar.-Apr. 1966). (In Rumanian).

The metabolism of calcium in the heart of irradiated frogs was studied, using ^{45}Ca as a tracer. The fixation of calcium in frog hearts irradiated with 3000 R x radiation was smaller than in normal frog hearts, with the difference becoming noticeable starting 10 minutes after administration of ^{45}Ca. (auth)

11096 ACTIVITY OF IONIZING RADIATION ON THE BUCCO-MAXILLOFACIAL REGION. Andrei, C. Rev. Sanit. Mil., 62: 527-36(May-June 1966). (In Rumanian).

Experimental and clinical data on the radiosensitivity of oral and dental tissues are reviewed. Data are included on the Japanese victims of nuclear bombs and the fishermen exposed to fallout near the Bikini atoll. Methods of prevention and treatment are discussed. (auth)

11097 STUDY OF NUCLEIC ACIDS IN THE HEPATIC TISSUE IN IRRADIATED ANIMALS. Marinescu, C.; Popa, Rodica; Florescu, Ioana. Rev. Sanit. Mil., 62: 519-26(May-June 1966). (In Rumanian).

Data on hepatic parenchymal DNA following different doses of whole-body irradiation in rats were determined by 4 methods. Results are reported from a study on 120 rats irradiated with 400, 560, 700, or 800 R, in which DNA was determined 1, 4, 6, and 9 days postirradiation. Results are presented and the suitability of methods discussed. (auth)

11098 SOME EFFECTS OF X IRRADIATION ON LARVAE OF GALLERIA MELLONELLA. Harshbarger, John C.; Moore, B. Shain (Univ. of California, Irvine). J. Inverteb. Pathol., 8: 277-9(June 1966).

Second- and third-instar larvae of the greater wax moth, Galleria mellonella, were irradiated at 12000 R at the rate of 500 R/min. Numerous cellular pathologies developed during the larval period that was extended as much as 2 months beyond normal. Pupation was often partially or completely inhibited. The effects of radiation on the integument, fat body, and structures within the hemocale are discussed. (TSS)

11099 ANTIBODY BEHAVIOR AFTER RADIOIODINE THERAPY. Klotz, H. G. (Medical Univ., Vienna). Fortschr. Geb. Roentgenstr. Nuklearmed., 105: 556-63(Oct. 1966). (In German).

The role of immune responses in the development of myxedema following radioiodine therapy for thyroid disorders is discussed in reference to the literature and clinical results. It is suggested that hyperthyroidism, Hashimoto's disease and myxedema may represent various stages of a single immunopathological entity. (H.G.D.)

11100 DOMINANT MUTATIONS AFFECTING THE SKELETON IN OFFSPRING OF X-IRRADIATED MALE MICE. Ehling, U. H. (Oak Ridge National Lab., Tenn.). Genetics, 54: 1381-9(Dec. 1966). (ORNL-P-2293).

Studies were made of the basic information on the frequency and nature of x-radioinduced dominant mutations affecting the skeleton of mice. In an experiment where the sample size was such that not more than one mutation would be expected for any particular gene locus, it seemed that the screening for mutations could best be made by dividing skeletal abnormalities according to whether they occurred only once (Class 1) or more frequently (Class 2). The manifestation of Class-2 abnormalities showed no statistically significant dependence on the treatment of the males. After a single exposure with 600 R, the excess, over the control, of Class-1 abnormalities per gamete per R was 3.5×10^{-5} for postspermatogonial stages, and 2.3×10^{-5} for spermatogonia. The most sensitive indication of mutations was probably the statistically significant increase in two subgroups of Class 1. If the assumption is correct, a total of 23 presumed mutations was observed in 1968 offspring derived from irradiated males, and one presumed mutation in 1,739 control offspring. The point estimate

for dominant mutations affecting the skeleton after single exposure with 600 R was 2.9×10^{-5} mutations/gamete/R for postspermatogonia, and 1.1×10^{-5} mutations/gamete/R for spermatogonia. The 95% confidence intervals were 1.6 to 5.2 and 0.4 to 2.5, respectively. The ratio between dominant mutations induced in spermatogonial and postspermatogonial stages was similar to the ratio found in specific-locus experiments. The result supports the notion that a sizable proportion of the skeletal abnormalities may result from gene mutations. (H.G.D.)

11101 CORRELATION BETWEEN HEMORRHAGIC CYSTITIS IN CATTLE AND NATURAL RADIOACTIVITY. Ionescu, D.; Luca, I.; Dulceanu, N.; Filip, D. (Institutul Agronomic Ion Ionescu de la Brad, Iasi). Lucrarile Stiint. Inst. Agron. Ion Ionescu de la Brad, Iasi, 283-8(1963). (In Rumanian).

Radio-assays were made on the natural radioactivity of the soil, forage vegetation, and bones of cattle in the Suceava region of Roumania where frequent outbreaks of hemorrhagic cystitis have been known to occur. As a control, the same types of radio-assay were carried out in the Jassy region where the disease has not occurred. A thin-window G-M counter was used to assay 100-g soil samples. In areas where hemorrhagic cystitis was endemic, the soil radioactivity counts were double those in areas free of the disease (>100 cpm/100 g soil vs ~50 cpm/100 g); the foraged vegetation by the cattle was about 4 times as radioactive; (>10,000 mμC/100 g vs 2500 mμC/100 g); and bone ash radioactivity counts from cattle in the endemic regions were 5000 mμC/100 g of ash as compared to <2800 mμC/100 g of ash from cattle in the Jassy region. (BBB)

11102 NOBLE GAS ION LASER AS A LIGHT KNIFE. Hoye, Robert C.; Minton, John Peter (National Cancer Inst., Bethesda, Md.). Surg. Forum, 16: 93-5(1965).

Results observed when the beam of a pulsed argon, ruby, and neodymium laser (wavelengths of 4880 Å and 5145 Å) was passed over living animal tissue are described. Unfocused, the beam was capable of continuously charring strips of tissue (3mm wide, 2mm deep) without damaging underlying structures. When optically focused, the beam would cut completely through tissue strips. The depth of incisions depended on the amount of energy in the laser beam and on how rapidly the beam was passed over the surface of tissue. Hemorrhage did not occur on the edges of the tissues cut with the beam; damage to adjacent tissues was minimal. The oncolytic property of the laser was evaluated by exposing transplantable mouse tumor systems to the beam. Complete or partial tumor destruction occurred in mice. When the beam was focused, celiotomy incisions in rabbits could be made. Control of the depth of the incision was satisfactory, and damage to underlying abdominal viscera was avoided. Intra-abdominal application of the focused laser beam provided precise and bloodless excision of large portions of the liver without damage to adjacent structures. (TSS)

11103 EXPERIMENTAL STUDY ON NEUTRON-INDUCED CATARACTS. Choshi, Kanji (Hiroshima Univ.). Jap. J. Ophthalmol., 9: 123-9(July-Sept. 1965).

Animal experiments were conducted to clarify the nature of fast neutron-induced lenticular damages as well as to determine the threshold dose of fast neutrons required to induce permanent damage to the crystalline lenses of adult albino rabbits. A T(d,n)He reaction neutron generator (NSH-4) was used as the 14.1-MeV neutron source. The eye at a target-limbus distance of 6 cm was irradiated in doses ranging from 2.5×10^8 to 9.6×10^{10} n/cm^2. It was suggested that with adult albino rabbits, the changes after exposure to more than 4×10^9 n/cm^2 are of a permanent nature even though the opacities are mild. The minimum dose of 14.1-MeV neutrons which would induce lenticular opacities, of a degree whereby diminished vision in man could be expected, is estimated to be ~3.2×10^{10} n/cm^2. Morphological changes in the lenses as determined by histopathological study and in vivo observation resembled the morphological changes of experimental radiation cataracts induced by x ray which have been reported previously, and changes peculiar to fast-neutron irradiation were not observed. (TSS)

11104 STATISTICAL OBSERVATIONS ON LYMPHOSARCOMA AND LEUKOSARCOMA AND THE PAS REACTION IN ABNORMAL LYMPHATIC CELLS IN NAGASAKI. Itoga, Takasi; Ouki, Keiichi (Nagasaki Univ.). Nagasaki Igakkai Zasshi, 38: Suppl., 154-61 (Dec. 1963). (In Japanese).

Statistics relating to leukemia and the PAS (periodic acid-Schiff) reaction in abnormal lymphatic cells in the Nagasaki population were studied. During the past 17 years 302 cases of leukemia were reported in Nagasaki. The incidence rate of chronic lymphatic leukemia was 3.3% and acute lymphatic leukemia 15.6%. During the period 1946–1955 the incidence of chronic lymphatic leukemia in whole population was 1.8% but was 0% in persons living in the city at time of onset of the disease. The incidence increased in 1956–1962: 4.2% of chronic lymphatic leukemia cases in the total population and 5.5% in city residents. The PAS test for abnormal lymphatic cells (granules in cytoplasm) was conducted in 17 cases of acute lymphatic leukemia, 9 of chronic lymphatic leukemia, 6 of leukosarcoma, 8 of Hodgkin's disease, and 4 of lymphatic tumor, while 18 healthy subjects were used as control. The percentage of positive reactions and degree of positivity of the PAS reaction (in arbitrary units, 1 to 400) increased in the following order: (1) Hodgkin's disease, rate of positive reaction 13-57%, degree of positivity 17-123; (2) acute lymphatic leukemia, 4-98%, 8-357; (3) lymphatic tumor, 32-68%, 37-126; (4) chronic lymphatic leukemia, 13-93%, 19-185; (5) leukosarcoma, 60-92%, 160-253; and controls, 1-14%, 1-20. (BBB)

11105 SEVERE RETROSIGMOID LESIONS FOLLOWING RADIOTHERAPY OF CERVIX UTERI CANCER. de Miguel, Jacinto (Real Academia de Medicina, Valladolid, Spain). Toko-Ginecol. Pract., 23: 129-34(Apr. 1964). (In Spanish).

Two case studies of injury to the large intestine as a result of radiotherapy for uterine cervical carcinoma are presented. Rectal complications from such treatment have decreased from ~23 cases per 100 to 16 cases per 100 in the past 15 years. In the case of a 54-yr-old woman, diarrhea and rectal bleeding occurred after Ra therapy, and at 6 months postirradiation, surgery was required to correct stenosis and perforation of the rectosigmoid segment from a perirectal abscess. Resection of the affected portion was followed by normal postoperative recovery. In the case of a 30-yr-old woman, radium and external radiotherapy for cervical cancer was followed by a slight radiodermatitis with cure of the cancer. Five months postirradiation, tenesmus and rectal bleeding indicated inflammation in the large intestine. Diagnosis was confirmed by endoscopy; an exploratory laparotomy was performed and normal bowel function was restored. (BBB)

11106 THYROIDECTOMY BY ^{131}I IN PATIENTS WITH SEVERE RESPIRATORY INSUFFICIENCY. (STUDY OF 3 CASES). Bernard, Etienne; Israel, Lucien; Vincent, Jean; Gamain, B.; Coby, J. (Hopital Laennec, Paris). J. Franc. Med. Chir. Thorac., 19: 703-11(Sept.–Oct. 1965). (In French).

Three cases in which ^{131}I was used to produce hypothyroidism are described. The characteristics of the iatrogenic disease are also described. Total radioinduced destruction of the thyroid gland was carried out to alleviate severe right ventricular impairment in three patients with respiratory distress. Single doses of 15 mC ^{131}I were administered and repeated as many as three times to induce hypothyroidism. In all cases therapeutic induction of hypothyroidism resulted in relief of respiratory distress and increased physical work capacity; decreased ventilation volume, oxygen consumption, and cardiac frequency; and produced a marked increase in cholesterolemia. Hypercapnia was decreased in two of the three cases. While the radioiodine-induced destruction of the thyroid was therapeutically effective in these three cases, and showed that hypothyroidism could be controlled by administering thyroid extract, the report emphasized that such drastic treatment should be reserved for severe cases where marked reduction of thyroid function may be useful. (BBB)

11107 HETEROTRANSPLANTATION OF HUMAN LEUKEMIC CELLS AND CELL CULTURES IN THE LETHALLY X-IRRADIATED SYRIAN HAMSTER. Adams, Richard A.; Farber, Sidney; Foley, George E.; Uzman, Betty G.; Lazarus, Herbert; Watrouse, Patricia (Children's Hospital, Boston). Cancer Res., 26: 2190-5(Oct. 1966).

Lymphoblasts obtained directly from the peripheral blood buffy coat of a child with acute lymphoblastic leukemia partially or completely repopulated the depleted bone marrow spaces of two hamsters intravenously infused shortly after whole-body irradiation in the supralethal dose range. A more extensive series of experiments with lymphoblasts (CCRF-CEM) isolated directly in continuous suspension cultures from the same patient's blood buffy coat, gave similar results. The results are discussed in terms of the potential utility of this kind of experiment, based on the bone marrow protection model, for: the heterotransplantation of human leukemic cells; investigation of the biology of human leukemic cells; and the monitoring of cell cultures of hemic or lymphoid origin. (auth)

11108 LIVER SCANNING IN THE ASSESSMENT OF LIVER DAMAGE FROM THERAPEUTIC EXTERNAL IRRADIATION. Usselman, James A. (Naval Hospital, San Diego, Calif.). J. Nucl. Med., 7: 761-72(Oct. 1966).

Five case histories of patients subjected to external irradiation for treatment of testicular tumors are presented together with liver scans made as part of preparation and evaluation during and after therapy. The scans appear to provide a reliable indication that the liver is more susceptible to external irradiation than had been thought and that moderate dosage may be sufficient to pro-

duce dysfunction. When the left lobe of the liver was irradiated through mediastinal portals, scans showed sharp vertical cutoff of activity in the portion of liver in the treatment beam. Later examinations implied that the dysfunction was not temporary, but the likelihood of metastatic disease was ruled improbable. (H.G.D.)

11109 EARLY DIAGNOSIS IN CHRONIC MYELOID LEUKEMIA. Okada, Kosuke; Kamada, Nanao; Tanaka, Nobuo (Hiroshima Univ.). Nagasaki Igakkai Zasshi, 38: Suppl., 150-3(Dec. 1963). (In Japanese).

A case is described in which early diagnosis of chronic myeloid leukemia of atomic bomb survivors was studied. A 50-yr-old female patient was exposed to the atomic bomb explosion in 1945 at a distance of 1400 m. In 1962, the patient showed a leukocyte count of 13,000 per mm^3 and was hospitalized. Abnormalities were demonstrated in hematological examination: slight anemia, slight increase in leukocytes, increase in basophils, appearance of young neutrophils, decrease in neutrophil alkaline phosphatase activity, and appearance of drumstick forms (20 per 1000 neutrophils in males, normal value 0–6, and in females 8–47). Among the 39 bone marrow cells examined, 35 (90%) were found to have a chromosome number of 46, and 24 (62%) showed the Philadelphia chromosome. The abnormal hematological picture, with the appearance of young cells, slightly increased leukocytes, and derangements in basophil count and enzyme activity were important features in the diagnosis of chronic myeloid leukemia. The demonstration of the Philadelphia chromosome is also significant in the early diagnosis of chronic myeloid leukemia. (BBB)

11110 TISSUE PROTEINASES (CATHEPSINS) OF RAT LIVER AND KIDNEYS AFTER NEUTRON IRRADIATION. Sadykhov, S. T. Izv. Akad. Nauk Azerbaidzh. SSR, Ser. Biol. Nauk, No. 6, 105-8 (1966). (In Russian).

Exposure of rats to neutrons at a total dose of about 6 rads caused significant alterations in the activity of hydrolases of liver and kidney tissues. The activity increased during the first 5 days after exposure to a single whole-body dose. This increase was followed by a decrease and an increase again on the 30th post-irradiation day. It was concluded that the increase in hydrolase activity was due to the inactivation of the enzyme inhibitors. (C.H.)

11111 ATOMIC RADIATION AND ITS EFFECTS ON HEALTH. Trainor, D. C. Sydney, New South Wales Dept. of Public Health, 1966. 81p.

The effects of radiation on human life and health are discussed in simple non-scientific language. The principles of atomic physics are presented briefly and sources of radiation, isotopes, and units used to measure radiation are discussed. The biological effects of radiation are reviewed, with emphasis on genetic and somatic effects. Early radiation accidents and the effects of massive radiation doses on human populations are described. Maximum permissible doses of radiation for various age groups and safety standards to ensure the protection of the population against radiation exposure are discussed. The contributions of natural background radiation, fallout, diagnostic radiography, radiotherapy, and miscellaneous sources to the radiation dose received by man are considered. It is pointed out that radiation doses received during occupation exposure have been maintained at acceptable levels. Applications of radioisotopes in industry, research, and clinical diagnosis and radiotherapy are reviewed briefly. It is pointed out that the benefits of atomic radiation to mankind overshadow any ill effects of radiation on man. (C.H.)

Radiation Effects on Plants

Refer also to abstracts 10743, 10812, 10817, 10820, 10829, 10835, 10839, 10840, 10842, 10845, 10846, 10928, 10992, 11003, 11010, and 11162.

11112 (RLO-353-9) STUDY OF FACTORS THAT GOVERN RADIOSENSITIVITY OF PLANTS. Progress Report, November 1, 1965–October 31, 1966. Nilan, Robert A.; Konzak, C. F. (Washington State Univ., Pullman). Nov. 1, 1966. Contract AT(45-1)-353. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The effect of water content on the oxygen sensitivity of irradiated barley seeds was studied. Results indicated that there was a critical region in which a small change in water content greatly altered the response to post-radiation hydration in oxygen-saturated water. Seeds stored after irradiation in oxygen at 75°C showed a decrease in seedling injury compared with those stored at 28°C. This effect was not observed if they were stored in nitrogen. Seeds were irradiated in vacuo with 15 kR gamma radiation for oxygen hydration or 40 kR for nitrogen hydration. Hydration was carried out in phosphate buffers at pH 3, 7, and 11. In seeds that were stored for two weeks after irradiation the oxygen-dependent injury in pH 3 solution was 15%; in pH 7, 100%; negative injury in pH 11. An experiment was conducted to study the effects of x rays of different energies on the oxygen-effect. Seeds were rehydrated in nitrogen-saturated water and oxygen-saturated water. From 300 to 225 kV, the oxygen-dependent injury was 60%; from 225 to 200 kV, the injury dropped to 30%. Other studies included the degree of oxygen-radical interaction in very dry seeds in relation to oxygen and nitrogen hydration, the effects of fractionated doses on the oxygen effect following radiation in seeds of different water contents, the influence of radical scavengers on the oxygen effect, protective effects of dimethyl sulfoxide for oxygen dependent damage in seeds of low water content, and seed respiration. Experiments were carried out on enzyme activity in irradiated seeds. The presence of peroxides in irradiated flax seeds was indicated by the thiobarbituric test. It was noted that aged seeds of barley contained decreased amounts of catalase and peroxidase. Catalase activity was higher in seeds pretreated by hydration in gibberellic acid. After irradiation with doses of 10,000 and 16,000 R an interaction was found between the gibberellic acid and the effect of irradiation. (H.L.W.)

11113 EFFECTIVENESS OF IRRADIATION OF POTATO TUBERS BEFORE PLANTING. Lure, L. S.; Prokofev, N. S.; Serebrenikov, V. S. Radiobiologiya, 6: 741-3(1966). (In Russian).

The results of the productivity examination of potato tubers exposed to γ irradiation at doses of 300 R before planting are tabulated. The results confirm the yield increase of potato tubers irradiated before planting. (J.S.R.)

11114 INFLUENCE OF X RAYS ON GERMINATION OF SPORES AND DEVELOPMENT OF SPROUTS OF FERN (PTERIS LONGIFOLIA L.). Verkhovskaya, I. N.; Nefedova, A. I. Radiobiologiya, 6: 744-8(1966). (In Russian).

During the irradiation of spores of the fern, Pteris longifolia L., with increasing doses of x radiation (from 25 to 300 kr), a reduction of the number of intergrown spores and depression of cell division in the prothallus occurred. The characteristic types of abnormalities in the development of the prothallus, which appear independently of the x-radiation dose, were determined. The indicated deviations are non-specific for radiation damage. They are also found in prothallus, produced from non-irradiated spores, if the germination in the first 5 to 10 days was done under conditions of partial or complete darkness. (tr-auth)

11115 INTENSIFICATION OF PRODUCTIVITY OF BARLEY BY PRESOWING γ IRRADIATION OF SEEDS. Sabin, V. N.; Shutov, A. A. Radiobiologiya, 6: 749-50(1966). (In Russian).

Barley seeds were exposed to γ irradiation doses of 1.6 and 2.4 kr before sowing, and the variation in the productivity with respect to non-irradiated controls was determined. The results are tabulated and show that the doses administered cause a reduction in the productivity and an inhibition of the growth of the principal shoot. Changes in the bushiness were reflected in the seed productivity of the plants. (J.S.R.)

11116 INFLUENCE OF IRRADIATION OF SEEDS ON MOBILITY OF CYTOPLASM, OXIDATIVE PHOSPHORYLATION, AND ATP-ASE ACTIVITY OF MITOCHONDRIA IN THE CELLS OF MAIZE ROOTS. Tairbekov, M. G.; Kazantsev, E. N.; Tageeva, S. V. (Inst. of Biological Physics, Moscow). Radiobiologiya, 6: 731-3(1966). (In Russian).

The effect of the irradiation of maize seeds at 500 and 40,000 R on the oxidative phosphorylation, ATP-ase activity of the mitochondria, and the speed of the cytoplasm movement was investigated in the root cells of maize seedlings. The results showed that γ irradiation causes profound changes in the ultrafine organization and biochemical activity of the important cell mitochondria, which leads to changes of the entire level of the energy exchange of the cells. (J.S.R.)

11117 POSTIRRADIATION RECOVERY OF SEEDS OF DIFFERENT MOISTURE. Fesenko, E. V.; Poryadkova, N. A. Radiobiologiya, 6: 734-40(1966). (In Russian).

The postirradiation recovery of pea seeds was investigated as a function of the moisture content of the seeds. The seeds were exposed to 15 kR at dose outputs 20 r/min. The time-effect curve of the mitotic activity, types of chromosome aberrations, and number of primary damages were determined as a function of the moisture content. The results showed that the extent of primary cytogenetic injuries, caused by the irradiation, does not depend on the moisture content of seeds. Differences in the cytogenetic effect and survival of the plants are connected with the different degrees of recovery of damaged cells in seeds with different moisture contents. (J.S.R.)

11118 THE GERMINATION CAPACITY OF X-IRRADIATED SEEDS OF SOME VARIETIES OF ALLIUM CEPA L. Srb, Vladimir (Karlovy Univ., Hradec Kralove, Czech); Hora, Jiri. Genet. Slechteni, 2: No. 3, 161-8(1966).

Five varieties of onions were subjected to different doses of x radiation (100, 1000, and 5000 R) to test seed germination. A statistically significant stimulatory effect of the smallest dose used (100 R) was manifested in Vsetatska variety (by 10% increase in germination as compared with the control) and Kasticka variety (by 5%). In Kasticka variety also the dose of 1000 R was stimulatory (by 5.9%). There was no statistically significant effect with the dose of 5000 R. In Kvetoslavska, Obrovska zluta, and Moravanka varieties an effect of x radiation on germination was not manifested. It is evident that the seed of different varieties of A. cepa differ in their radiosensitivity as regards germination ability. (BBB)

11119 RESPONSES OF FERN GAMETOPHYTES TO ULTRAVIOLET RADIATION. Kato, Yukio (Nagoya Univ., Japan). Phyton (Buenos Aires), 23: No. 1, 23-7(1966).

The effects of uv radiation on the developing gametophyte of Pteris vittata were examined. Measurements were made to determine the effects of cell age followed by culture conditions and the time of irradiation on the cell survival. When gametophytes grown under white light of low intensity were irradiated with a high dose of uv, an apico-basal gradient in the ability to survive was demonstrated in young filaments and older prothalli. If gametophytes grown under white light of high intensity were irradiated with uv, the survival of each of the cells composing a gametophyte was controlled by two different factors: a marked ability for cell division or rapid recovery from the injury of uv at the apical region and high resistance to uv at the basal region. The data are interpreted as showing an age-dependent change in the capacity of the cells to respond to uv irradiation. (BBB)

11120 INHIBITION OF MITOSIS IN PISUM ROOT MERISTEMS BY CONTINUOUS GAMMA RADIATION: THE INFLUENCE OF TEMPERATURE ON THE SYNTHESIS OF DNA, RNA, AND PROTEIN DURING INHIBITION. Van't Hof, Jack (Univ. of Minnesota, Minneapolis). Amer. J. Bot., 53: 246-52(Mar. 1966). (BNL-9067-R).

Tritiated precursors of DNA, RNA, and protein were used to measure synthesis at 10 and 20°C in root meristem cells of Pisum sativum after they were mitotically arrested by continuous irradiation (60 R/hr, 20 hr/day for 3 days) with γ rays. The experiments were designed to determine if the arrested cells accumulated in a certain part of interphase, to determine the effect on DNA, RNA, and protein synthesis, to find out if the effects were temperature dependent, and finally to reveal possible relations between growth inhibition and altered synthesis. The results showed that the incorporation of DNA and RNA precursors was impaired by irradiation and that decreased temperature further increased radiation impairment of DNA synthesis. Protein synthesis, on the other hand, was not impaired by irradiation at either temperature. Irradiation at 20°C reduced the number of DNA-synthesizing cells; at 10°C this number was reduced to near zero. Although irradiated cells synthesizing RNA showed a reduction in grain counts when compared to the controls, they still retained the ability to incorporate tritiated uridine at 10°C. It was hypothesized that the combination of reduced DNA and RNA synthesis and unaffected protein synthesis resulted in precocious maturation of the arrested meristem cells. Growth which occurred in the absence of cell division was attributed to meristematic cells which precociously matured and cells which were in the region of elongation. (BBB)

11121 EFFECT OF X-RAYS ON SEEDS OF SCOTS PINE FROM DIFFERENT PROVENANCES (PINUS SILVESTRIS L.). Ohba, Kihachiro (Inst. of Radiation Breeding, Ibaraki, Japan); Simak, Milan. Silvae Genet., 10: 84-90(May-June 1961).

Radiation sensitivity of Scots pine seeds collected from 10 different provenances in Sweden was studied. To avoid undesirable effects caused by varying seed quality, only fully developed seeds were used. The water content of the sample seeds was standardized between 8.1 and 9.3% by equilibration. The experiment provided the following doses of x radiation: 0, 600, 1200, 2400, 3600, and 4800 R. Fifty days after sowing, seeds and seedlings were observed with respect to the following characteristics (as indicators of radiation sensitivity): germinability, time of germination, seedling mortality, and seedling development (hypocotyl length and root length). Also evaluated was the radiation sensitivity of the seeds in relation to the ecological factors at the original habitats. The radiation sensitivity of seeds from different provenances varied widely. The ecological conditions of the provenances expressed by the length of the growing season were evaluated with respect to their importance for the radiation sensitivity. It was found that Scots pine seeds from provenances with a short growing season, northerly latitude, and high altitude were more resistant to x rays than seeds of southerly latitude and low altitude. The source of this variation in x-ray sensitivity may be attributed to specific physiological and biochemical features of seeds from places with different length of growing season, i.e., in variations in the content of water, proteins, fats, and enzymes. (BBB)

11122 INDUCTION OF SOMATIC CHANGES IN SOLANUM TUBEROSUM BY ACUTE GAMMA IRRADIATION. Heiken, Aage (Inst. for Plant Research and Cold Storage, Nynaeshamn, Sweden). Hereditas, 47: 606-14(1961).

The effects of ^{60}Co γ radiation on potatoes of the President variety were studied. In the first vegetative generation, there was a suppressing effect of radiation increasing from the lowest (250 R) to the highest dose (8000 R). The threshold value, giving about 50% lethality, was found to be 8000 R. However, on the basis of previous x-ray experiments, this value was regarded as an upper limit reached only under favorable conditions. In the second vegetative generation, 7 somatic aberrations were isolated. In relation to the total number of surviving families, they amounted to 6.7%. The permanence of the types induced was demonstrated during three years' propagation. Because changes in the morphology of the potato may be caused by virus infection, it was necessary to examine all the types induced for the presence of viruses, the test of transmission by grafting being considered the most conclusive. However, none of the aberrant forms isolated transmitted their characteristic features. The aberrant features included plants with light-green leaves, leaf deformities, dwarfed form, increased pigmentation of the corolla, depigmentation of corolla, and small leaflets. (BBB)

11123 INFLUENCE OF THE ANIONIC PROPORTIONS IN THE NUTRITIVE MEDIUM ON THE ABSORPTION, DISTRIBUTION, AND THE EFFECTS OF ^{32}P IN COTTON PLANTS. Dejaegere, Robert (Univ. Libre, Brussels). Ann. Physiol. Veg. Univ. Bruxelles, 10: No. 2, 23-43(1965). (In French).

The radiobiological effects of ^{32}P on some aspects of metabolism of cotton plants were studied under carefully controlled conditions of temperature, light, humidity, and mineral nutrition. It was shown that ^{32}P in tracer amounts alters the phosphorus uptake of the leaf of the plant. The influence of anions (nitrate, sulfate, phosphate) and cations (K, Ca, Mg) on this phenomenon was examined. The doses of ^{32}P used (20 and 60 μCi per pot) did not alter plant growth parameters (height of plants, number of leaves, total leaf surface area, dry weight of plants, or weight of leaves). Three factors influenced the effect of ^{32}P on phosphorus incorporation by the leaves: the rank of leaves on the plant; the concentration of anions in the nutrient medium; and specific activity of the medium. (BBB)

11124 EFFECT OF IRRITATION DURING PREPARATION ON THE UV RADIATION RESISTANCE OF THE OUTER EPIDERMIS OF ALLIUM CEPA. Hofer, Kurt (Univ., Vienna). Protoplasma, 61: 1-11(1966). (In German).

Sections removed from the scales of Allium cepa were exposed to uv light. Resistance of the cut sections to the uv light fell sharply within a few min, as compared to that of uncut samples. Increased numbers of dead cells were observed. The greater the time of exposure to the uv light source and the more the samples were washed or mechanically agitated prior to uv-irradiation, the greater were the effects observed. The results may have been related to mechanical injury of the cytoplasm. (BBB)

11125 EFFECTS OF IONIZING RADIATION AND OTHER ENVIRONMENTAL STRESSES UPON PINUS ELLIOTTII. McCormick, J. Frank (Univ. of Georgia, Athens). ASB (Ass. Southeastern Biol.) Bull., 11: 49(Apr. 1964).

Seeds, seedlings, and one-yr-old trees of Pinus elliottii were exposed to gamma radiation doses that ranged from 100 to 10,000 R. Germination, growth, survival, and physiological tolerances to environmental stresses were found to vary inversely with the radiation dose received. Radiation doses of 300 R and below were observed to be beneficial to plant growth and survival under certain environmental conditions. Radiation tolerances of seeds and seedlings were modified by applications of gibberellic acid; concentrations of 150 mg/l increased radiation tolerances of the plants. Results indicated that ionizing radiation can be a useful analytical tool in ecological studies and that irradiation may be applicable for use in agriculture since beneficial effects were observed. (BBB)

11126 ROOT DEVELOPMENT OF SOME CULTIVATED PLANTS IN SANDY SOIL: ORIENTING STUDIES CONDUCTED BY THE USE OF RADIOACTIVE ISOTOPES. Haahr, Vagner, Knudsen, Hardy; Nielsen, Gunnar; Sandfoer, Jens (Danish Atomic Energy Commission Research Establishment, Risoe). Tidsskr. Planteavl, 69: 554-67(1966). (In Danish).

An evaluation and comparison were made of the use of radiophosphorus and neutron absorption for measuring root development of some cultivated plants in light sandy soil. After injec-

tion of ^{32}P at different depths and different distances from the plants, the ^{32}P uptake was followed by measurement of the radioactivity in the above-ground parts of the plants. The water uptake by the plants from various depths was measured by the neutron probe method. The injections were carried out through plastic tubes in order to eliminate contamination of the injection channels. The results of the ^{32}P measurements showed that in the period May-July all the crops investigated had root activity at the greatest depth of injection, i.e., 70 cm below the ground. The measurements gave no exact quantitative information on the root activity, but indicated that, of the crops examined, oats and barley had the relatively greatest root activity at the greater depths. Grasses and clovers were compared by being grown in mixture. From the measurements it appeared that the grasses had a relatively greater root activity than the clovers at the greater depths. Horizontal root development was detectable up to 30-60 cm from the row of plants, but was quantitatively insignificant from a distance of about 30 cm. Water measurements by the neutron probe method were carried out for two years, 1961 and 1962, both of which were rather wet. Of the crops examined, oats and barley showed the largest water uptake from the greater depths. (BBB)

11127 KILLING AND MUTAGENIC EFFICIENCIES OF HEAVY IONIZING PARTICLES IN ARABIDOPSIS THALIANA. Fujii, T. (National Inst. of Genetics, Misima, Japan); Ikenaga, M.; Lyman, J. T. Nature, 213: 175-6(Jan. 14, 1967).

The killing and mutagenic effects of accelerated helium, carbon, and argon ions on seeds of Arabidopsis thaliana were investigated and compared with the effects produced by ^{137}Cs γ rays. The dose rate for all irradiations was about 4 to 5 krad/min. Germination and survival rates after the γ-irradiation were very high (about 90 percent). Survival rates decreased markedly with increasing dosage after heavy ion irradiations, and particularly so after helium ion irradiation (50 percent). The decrease was not so severe after carbon ion irradiation, and was still less with argon ions. Details are given of mutation rates. Effects of LET and RBE values are discussed. (UK)

11128 PRODUCTION OF GREEN ALGAE IN DEUTERIUM OXIDE. Williams, A. J.; Morse, A. T.; Stuart, R. S. (Merck, Sharp and Dohme, Montreal). Can. J. Microbiol., 12: 1167-73 (Dec. 1966).

The two species of green algae Scenedesmus obliquus and Chlorella vulgaris were successfully adapted and grown in 99.7% deuterium oxide in 15-liter culture units. The units average 50 to 60 g of dry cells every 10 to 12 days. The deuterium oxide used in the media was recycled after purification to maintain usage at practical values. (auth)

11129 CHROMOSOMAL ALTERATIONS IN PEARL MILLET INDUCED BY GAMMA RAYS. Pantulu, J. V. (Andhra Univ., Waltair, India). Nature, 213: 101-2(Jan. 7, 1967).

Dry seeds of a stock of Pennisetum typhoides carrying B chromosomes were ^{60}Co γ-irradiated to 10 kR, 20 kR, and 30 kR. The treated seeds were sown in pots and survivals subsequently field transplanted. Meiosis in the pollen mother cells was examined to determine the types of aberration produced. For cytological investigation young spikelets were fixed in acetic alcohol and anther squashes made in acetocarmine. The most common aberration was a ring or chain of four chromosomes. An aberration resulting in the formation of a chain of six and four bivalents was rare. More complicated configurations of A chromosomes occurred in one plant from seed exposed to 30 kR. The effect of x-irradiation was also investigated (42,000 R for 1 to 3 hours). From a comparison of results, it was apparent that aberrations induced by x rays and γ rays are to a large extent alike. (UK)

11130 IRRADIATION IN SUCCESSIVE GENERATIONS: EFFECTS ON DORMANT BARLEY (HORDEUM DISTICHUM, L.) EMBRYOS. Campbell, W. F. (Dept. of Agriculture, Logan, Utah). Radiat. Bot., 6: 535-43(Dec. 1966).

Dormant seeds of barley (Hordeum distichum L.) were treated with a single acute exposure of ionizing irradiation applied in each of three successive generations. Irradiation exposures, up to and including even the highest dose level (30,000 R), caused a maximum reduction of only 10% on germination proper, i.e., the emergence of root, coleoptile, and shoot. After the second irradiated generation, seedling height usually decreased, then after the third generation it increased. The decrease may have resulted from a buildup of genetic burdens (presumably chromosomal interchanges), followed by an elimination (involving haplontic and/or diplontic selection) of aberrant cells. Experimental results indicated that: the Hannchen germ line appears to be capable of adapting to irradiation as an additional environmental stress, and use of recurrent irradiation in consecutive generations, to increase and retain the frequency of mutations in this diploid variety of barley does not appear feasible because of its high level of discrimination against induced mutations. (auth)

11131 COMPARATIVE STUDY OF THE EFFECTS OF CHRONIC GAMMA IRRADIATION ON LYCOPERSICUM ESCULENTUM MILL. AND L. PIMPINELLIFOLIUM DUNAL. De Nettancourt, D.; Contant, R. B. (EURATOM-ITAL, Wageningen, Netherlands). Radiat. Bot., 6: 545-56(Dec. 1966).

Plants of Lycopersicum esculentum and L. pimpinellifolium were γ-irradiated (^{137}Cs), from the 2-leaf stage onwards, at 0.36, 1.9, 4.7, and 7.5 rad/hr throughout their life, and at 17.3 and 50.0 rad/hr for shorter periods corresponding to 5 doses at each of the dose rates. The vegetative apex of L. pimpinellifolium expressed a greater sensitivity to chronic irradiation than that of L. esculentum. In contrast, with regard to flowering, fruit formation and seed-set during whole-life exposure, L. pimpinellifolium was much more radioresistant and withstood dose rates that rendered L. esculentum completely sterile. Leaf formation and plant height were markedly enhanced in both species with increasing dose rate in those plants that failed to flower; this is suggested to result from an accelerating effect of irradiation upon maturation of the older leaves. Among flowering plants, the number of leaves below the first inflorescence slightly increased with dose and dose rate. In the progeny of plants exposed during their whole life, the frequency of plants with chlorophyll-deficient sectors increased linearly with dose rate but was much higher in L. pimpinellifolium than in L. esculentum; slight morphological aberrations on the other hand prevailed in the latter. It is concluded that the relative sensitivity of the two species to chronic γ-radiation may be completely reversed depending on stages irradiated and criteria observed. If research requirements are such that large numbers of M_2 seeds are needed after exposure to high doses of chronic γ-radiation, results imply that the dose distribution over the vegetative and generative stages will have to differ for each of the two species. (auth)

11132 RADIATION ENHANCED OUTCROSSING IN JUTE (CORCHORUS OLITORIUS L.). Basak, S. L. (Presidency Coll., Calcutta). Radiat. Bot., 6: 557-60(Dec. 1966).

Amounts of cross pollination were estimated in x-irradiated and non-irradiated segregating (F_2) populations of jute for a monogenic factor using red as a seedling marker character. Cross pollination was found to be greater in the irradiated than in the non-irradiated population. The reason for the increase in cross pollination is presumably due to radioinduced pollen sterility. The method of promoting cross pollination can be utilized more efficiently where artificial crossing is difficult. Complications arising in selection of mutants in mutation breeding are discussed. (auth)

11133 IRRADIATION IN SUCCESSIVE GENERATIONS: EFFECTS ON DEVELOPING BARLEY (HORDEUM DISTICHUM, L.) EMBRYOS IN SITU. Campbell, W. F. (Dept. of Agriculture, Logan, Utah). Radiat. Bot., 6: 525-34(Dec. 1966).

Seeds of Hannchen barley (Hordeum distichum L.), at four specific embryonic stages, were used to investigate the effects of ionizing irradiation applied in each of three successive generations. Effects on germination, seedling vigor, survival to maturity, fertility and induced abnormalities were observed. Germination was very good following irradiation of the four specific stages of embryogeny, except for the early proembryo stage. Seedlings arising from embryos treated at the early proembryo stage were generally the most radiosensitive, while the late proembryo stage was the least, with the early and late differentiation stages somewhere between in sensitivity. For many of the criteria used to measure the effect of irradiation the late differentiation stage was equally as sensitive as the early proembryo stage. Based on seedling vigor this variety of barley did not seem to be any more sensitive to irradiation after the third consecutively treated generation than after the first; the coleoptiles even showed an increase in height spanning the three generations. Leaf and coleoptile abnormalities were minimal after three successive generations of treatment and were correlated with specific stages irradiated. Experimental results indicated that: careful consideration should be given the criterion used to measure the effect and the ontogenetic stage of development at the time of irradiation should receive special attention. (auth)

11134 ^{65}Zn DISTRIBUTION AND RADIOSENSITIVITY OF GROWTH AND ^{65}Zn UPTAKE IN RED OAK SEEDLINGS. Brown, G. N.; Taylor, F. G. Jr. (Oak Ridge National Lab., Tenn.). Radiat. Bot., 6: 519-24(Dec. 1966). (ORNL-P-2242).

External fast neutron irradiation of red oak seedlings (Quercus rubra L.) inhibited primary and secondary stem growth, root growth, and new leaf development. An initial stimulation of ^{65}Zn uptake was observed following irradiation, but ceased to be significant 22 days post-irradiation. Retardation of ^{65}Zn uptake was found several weeks following exposure of seedlings to 1000 rad. Physiological explanations for growth inhibition and both stimulation and inhibition of ^{65}Zn uptake are discussed. At the end of a

growing season, ^{65}Zn was most highly concentrated in secondary roots, followed by primary roots, stems, and leaves in decreasing order: 91, 7.7, 0.83, and 0.42 percent of the total. (auth)

11135 EMBRYO SAC DEVELOPMENT IN RELATION TO POLLEN FERTILITY AND SEED SET IN APPLE CLONES PRODUCED FROM ^{60}Co IRRADIATED DORMANT BUDS. Barritt, B. H.; Eaton, G. W. (Univ. of British Columbia, Vancouver). Radiat. Bot., 6: 589-96(Dec. 1966).

Investigations were made of the associations among megagametogenesis, pollen morphology, and seed production in clones of two irradiated apple cultivars, Golden Delicious and McIntosh. The clones examined were the second vegetative generation from buds irradiated while dormant with 5 kR from a ^{60}Co source. In 1964 and 1965 8 to 10 clones of each variety were selected on the basis of low, medium, and high pollen abortion. Golden Delicious and McIntosh clones with normal pollen production, approximately 90 and 50% respectively, had the highest proportion of embryo sacs at the differentiated 8-nucleate stage, and the smallest proportion of embryo sacs at the 2- and 4-nucleate stages. Irradiated clones with the least normal pollen had the highest proportion of immature 2- and 4-nucleate embryo sacs. With both varieties reduced pollen fertility was positively correlated with retarded embryo sac development in two successive years. Check clones with high pollen fertility had the highest number of developed seeds per fruit and irradiated clones with reduced pollen fertility had the smallest number of developed seeds per fruit. The number of developed seeds per fruit was positively correlated with the proportion of mature 8-nucleate embryo sacs. The reduction in seed number in irradiated apple clones with reduced pollen fertility may be explained in part by retarded embryo sac development. (auth)

11136 HERBACEOUS RECOLONIZATION OF THE BROOKHAVEN IRRADIATED FOREST: THE FIRST THREE YEARS. Wagner, R. H. (Brookhaven National Lab., Upton, N. Y.). Radiat. Bot., 6: 561-5(Dec. 1966). (BNL-10266).

Chronic γ-irradiation of an oak-pine forest in central Long Island, New York, has killed most species of higher plants originally present wherever average exposures exceeded 45 R/day. The central devastated zone is being invaded slowly by relatively radiation resistant herbs, including especially a sedge, Carex pensylvanica, which is indigenous to the forest. Of the other herbaceous invaders, such as Erechtites hieracifolia, set of viable seeds is reduced to less than 50% by exposures of 100 R/day or more. There is a clear selection favoring perennial species with shielded perennating buds and vigorous asexual reproduction. This pattern is accentuated by rabbits that find the radiation-devastated zone an attractive feeding ground and check the expansion of populations of herbaceous plants by grazing the flowering stems. Grazing has been especially effective in limiting the spread of the common old-field successional species, Erigeron canadensis. The overall successional pattern indicates that invasion by Carex will predominate, ultimately resulting in a dense Carex mat, excluding even other radioresistant herbs. (auth)

11137 MITOCHONDRIAL RESISTANCE TO MASSIVE IRRADIATION IN VIVO. III. SUPPRESSION AND RECOVERY OF RESPIRATORY CONTROL. Romani, R. J.; Yu, Ida K. (Univ. of California, Davis). Arch. Biochem. Biophys., 117: 638-44(Dec. 1966). (UCD-34P112-25).

Mitochondria capable of respiratory control were isolated from pear and apple tissues. Respiratory control, as an index of mitochondrial integrity, was then used to assess dose-dependent radiation damage and postirradiation recovery in vivo. Dose thresholds for suppression of respiratory control lie between 250 and 500 Krad. Recovery of respiratory control will occur 48 hours after doses of 500 and 750 Krad. There is no recovery in a similar period following a dose of 1000 Krad. Such marked radioresistance on the part of fruit mitochondria is in concert with other responses of this tissue to ionizing radiation. Cytological implications are discussed with reference to the established radiosensitivity of animal mitochondria. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 10727, 10789, 10797, 10836–10838, 11003, 11010, 11047, 11091, and 11137.

11138 (NYO-3116-4) REACTIONS OF BACTERIAL CELLS TO FOREIGN NUCLEI ACIDS. Progress Report, November 1, 1965-October 31, 1966. Ginoza, William (Pennsylvania State Univ., University Park. Dept. of Biophysics). Aug. 1966. Contract AT(30-1)-3116. 6p. ORAU.

X- and γ-irradiation results obtained under target theory conditions for T1, T2, T4 and λ phage show respectively the following α's (lethality per primary ionization (p.i.) absorbed in the nucleic acid): 0.03, 0.05, 0.05 and 0.09. These values compare with 1.0 for ϕX174, 0.25 for the infectious RF-DNA of ϕX174 and 0.43 for polyoma virus. Three hypotheses have been considered to explain the low α of these double-stranded DNA viruses: 1) only double-strand scissions can inactivate and they occur at a frequency, α; 2) host-cells on which the survival rate is measured can repair radiation lesions; and 3) α is a measure of the frequency at which some "critical" target within the viral genome is "hit." The wide variation in the α among these viruses and the similarity of the effectiveness of p.i. of X- and γ-rays with that of the radioactive decay of ^{32}P and ^{3}H atoms for T2 and T4 makes 1) unlikely. As a test of 2) x-irradiated T4 was assayed on various permissive host-strains of Escherichia coli, known to have different capacity to repair radiation lesions in their DNA. Survival rates of T4 were in indistinguishable using strains B/r, B, B_{s-1}, K12 (λ), K12 AB2464 rec$^-$ and UV'd B. Host-repair is detectable to a minor extent (10 to 20%) for T1 phage and λ phage assayed on E. coli strains B and C, respectively. Under hypothesis 3)α is expressed in terms of a "critical" target molecular weight. Each virus is thought to have a certain genetic content which must be expressed ("early" functions) before phage development can be initiated. A single "hit" in this target inactivates. $\alpha < 1$ implies that sublethal "hits" can exist in the phage genome. A possible "restitution" mechanism, distinct from host-cell reactivation, as a means of by-passing these "hits" is discussed. (auth)

11139 (ORO-2832-47) RADIATION STUDIES ON BACTERIAL AND ANIMAL VIRUSES. Activities Report, October 15, 1963–October 15, 1966. (Anderson (M. D.) Hospital and Tumor Inst., Houston, Tex.). Contract AT(40-1)-2832. 18p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The amount of direct and indirect effect of γ radiation on the DNA of T2r phage in E. coli was determined. Not more than 33% of the radiation effect upon T2r DNA in a host bacterium was by direct effect, the remainder being a consequence of indirect action. Percentages of the same magnitude were found for irradiation in air and in nitrogen. An oxygen enhancement ratio of 1.6 was found both in the liquid state and the frozen state. Addition of 1M glycerol (in air) conferred radiation protection in the liquid and the frozen states. Protection was 3-fold at 0° (liquid) and about 35% at –160°C. An apparatus was designed to provide both electron and heavy particle beams of energies from 0 up to 1 MeV for irradiation of samples in various controlled environmental conditions. Modes of operating the apparatus are described. Light and electron microscopic studies of the properties and structure of isolated unfixed mitotic chromosomes of hamster cells grown in vitro were carried out. Observations of gross structure were consistent with a proposal that a multistranded arrangement of the mitotic chromatid results from the condensation of an initial microfibril by a doubling-over-twisting-up sequence that leads to a compound co-helical structure. The fine structure appeared to be made up of DNA double-stranded molecules maintained in groups (of two or more) by cross-linking protein molecules. Improved isolation techniques were developed using synchronization techniques to obtain mitotic cells, various hypotonic, enzymatic, and shearing treatments to rupture cell membranes, and low-speed centrifugation in zone density gradients to partially purify chromosome material. A technique is reported that provides for light microscopic observations of hydrated chromosomal material during various treatment conditions followed by electron microscopic studies of the same material. A study of mammalian histone fractions was initiated as part of a more general investigation on the fine structure of chromatin and the radiosensitivity of genetic material. Studies on the RBE of various radiations upon T2 phage as free phage with cysteine present and as DNA within the host bacterium showed that either repair mechanisms are not available to the phage within the bacteria, or the postulated repair mechanisms are unessential to the mechanisms that give rise to the maximum in RBE of cellular organisms. (H.G.D.)

11140 (ORO-2832-48) RADIATION AND BIOPHYSICAL STUDIES ON VIRUSES AND CELLS. Progress Report, November 11, 1965–November 11, 1966. Shalek, Robert J.; Ansevin, Allen T.; Cole, Arthur; Humphrey, Ronald M. (Anderson (M. D.) Hospital and Tumor Inst., Houston, Tex.). Contract AT(40-1)-2832. 42p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Mammalian chromosomes were studied with light and electron microscopes. Mitotic chromosomes were isolated from hamster cells grown in culture, attached to microscope slides and x irradiated. The chromosome undergoes reversible swelling-condensation cycles without loss of material, organization, or structure when exposed to various chemical environments within specified concentrations. The effects of varying concentrations of KCl on swelling and condensation of irradiated chromosomes were

studied. It appeared that the extent of swelling was the determining factor which led to the observed radiation damage. Effects of EDTA on the chromosomes were similar to the effects of KCl. Some protection against radiation damage was obtained with cysteine. Progress is reported on studies on lethality of single- and double-chain breaks in bacteriophage DNA within host bacteria; analysis of subunit size and association properties of histone protein; and studies of radiosensitive sites in microorganisms with the aid of a new apparatus which provides both electron and heavy particle beams for irradiation of samples in various controlled conditions. (H.L.W.)

11141 ISOTOPE EFFECTS ON THE MORPHOLOGY OF FULLY DEUTERATED BACTERIOPHAGE T_2. Flaumenhaft, E. (Univ. of Akron, Ohio); Katz, J. J. Nature, 213: 501-2(Feb. 4, 1967).

Gross changes in the isotopic composition of living organisms may result in gross changes in the structure of cells and organelles. Morphological changes attendant on isotopic substitution are particularly interesting, since the altered organisms are viable and biologically competent, and correlations between structure and function become possible. Deuterated bacteriophage have been found useful in genetic and biochemical studies; the present authors examined deuterated phage by electron microscopy to determine the morphological consequences of deuteration on a virus. Escherichia coli B and bacteriophage E. coli T_2 were employed in the studies. Deuterated T_2 bacteriophage were found to be larger and different in shape than phage grown under normal conditions. There also appeared to be structural differences, particularly in regard to the tail. However, it is considered that mere immersion in D_2O is not sufficient to produce the observed differences. The authors are inclined to the view that the peculiarities result from the size and location of the protein sub-units. (auth)

11142 EXPERIMENTAL INFECTION OF MONKEYS OF THE SPECIES M. RHESUS WITH POX-VIRUS VARIOLAE AND P. OFFICINALE AFTER PREIMMUNIZATION WITH NONINFECTIOUS ANTIGEN. Danes, L.; Blazek, K. (Military Inst. of Hygiene, Epidemiology, and Microbiology, Prague). J. Hyg. Epidemiol. Microbiol. Immunol., (Prague), 10: 109-14(1966).

In a study of the properties of noninfectious antigen prepared from vaccine virus by γ irradiation, the effect of immunization with the antigen on the manifestations of experimental infection with P. variolae and P. officinale was determined in monkeys. The vaccine was prepared by inactivating virus grown in chick embryo cultures with a 5-Mrad dose of γ rays. It is concluded that use of the irradiated noninfectious antigen cannot replace the conventional method of vaccination, but its use is justified in special cases, e.g. for preimmunization of nonimmune individuals in contact with severe forms of vaccinia. (TSS)

11143 INHERITANCE OF GENE DIFFERENCES IN NEUROSPORA CRASSA. Rieke, Jean Ann. Trans. Kansas Acad. Sci., 66: 167-70(1963).

After Neurospora crassa was treated with x rays, the potentially mutant mold was grown on agar supplemented with substances that might be involved in biochemical mutation. Four types of supplemented agar were used: arginine, nicotinic acid, pyridoxine, and thymine. Tubes containing minimal agar were inoculated with Neurospora, and incubated at 37°C. After five days of growth, the tubes were irradiated with 100 R of x rays, and were incubated for two days after irradiation. A series of transplants was then performed; four tubes each of the supplemental arginine, nicotinic acid, pyridoxine, and thymine agars were inoculated with the irradiated culture. On the following day none of the 4 tubes of x-irradiated mold appeared to be growing on the arginine agar, 2 of the 4 tubes of culture were growing on nicotinic acid, and all 4 of the tubes of culture were growing on pyridoxine and thymine. (At this time the irradiated mold was also growing on the minimal agar but it began to die within a day.) A second experiment followed the same procedure, and a quantitative determination of the growth rate was also made. (BBB)

11144 ACTION OF ^{60}Co GAMMA RAYS ON DECARBOXYLATIVE ENZYMES IN BACTERIA. Zaio, A.; Curatola, G. (Centro Studi e Ricerche della Sanita Militare, Esercito, Italy). Minerva Med., 56: 3966-9(Nov. 14, 1966). (In Italian).

The radioresistance of decarboxylative enzymes present in bacterial suspensions and in extracts of bacteria was investigated in the strains Aerobacter aerogenes, Proteus, Bacillus cereus, Bacillus mesentericum, and Clostridium welchi. The suspensions and extracts were exposed to 2.5×10^5 and 2×10^6 rad and the percent survival and enzyme activity were determined. The rad dose necessary for the inactivation of the enzyme activity varies between 5×10^5 and 1×10^6, much lower than the values reported in the literature for other enzymes. The decarboxylase of glutamic acid showed a radioresistance almost equal in both suspension and extract. The addition of coenzyme to the suspensions and extracts did not cause the regeneration of the enzyme. (J.S.R.)

11145 ACTION OF ULTRAVIOLET RADIATION UPON CILIARY MOVEMENT IN PARAMECIUM. Saier, F. L.; Giese, A. C. (Stanford Univ., Calif.). Exp. Cell Res., 44: 321-31 (Nov.-Dec. 1966).

The effect of uv radiation upon ciliary movement of Paramecium multimicronucleatum was studied by: recording photographically tracings before and during irradiation, of the pathway traversed by an animal during 7 sec; and by stroboscopic measurement of ciliary rate before and during irradiation. Both measurements showed that the first effect of irradiation is increased rate of ciliary movement. The increase in rate varied inversely with the intensity of uv radiation. The period of increased ciliary rate was dependent upon dose. The increased rate of ciliary beat induced by irradiation subsides and is followed by a decrease in rate until translational movement ceases. Adenosine triphosphate solutions did not accelerate ciliary movement slowed by uv treatment. Ultraviolet-irradiation induces not only a slowing in the beat of the cilia but also a change in pattern of movement of the Paramecium that is recorded in the photographic tracings. Differential uv action on the body cilia as against the oral groove cilia appears to explain the various patterns obtained. The data are related to the findings in the literature. (auth)

11146 RADIOSENSITIVITY OF SOME PHAGES OF S. MARCESCENS AND E. COLI. Janovska, E.; Koudelka, J.; Kleinwaechter, V. (Inst. of Biophysics, Brno). Folia Microbiol. (Prague), 9: No. 3, 200(1964).

An attempt was made to induce formation of the phages kappa (Serratia marcescens) and S_d (Escherichia coli) by x-irradiation. The following phages were irradiated: S_d, kappa, c-mutant (clear plaques) of kappa phage, induced by uv, in which the rate of reversion to the mat type was investigated. For comparison, the radiosensitivity of phage T2 was also examined. The phages were irradiated either in broth or in synthetic medium M-9 under both normal and anoxic conditions. In kappa phage the rate of mutation was insignificantly increased by x irradiation in broth; with kappa in medium M-9 and with phage S_d no mutants were found. In c-mutant also, no reversion was observed. By comparison of the shape of the inactivation curves of the various phages, it was found that E. coli phages T2 and S_d are about twice as sensitive as phages of S. marcescens. It is thus roughly estimated that kappa phage and its c-mutant contain about half the amount of DNA as phage T2. The anomalous course of inactivation of S_d phage in synthetic medium under anoxia may be related to an anomaly in the structure of DNA in this phage. (BBB)

11147 COMPARISON OF THE INACTIVATION AND ANTIGENICITY OF FOOT-AND-MOUTH-DISEASE VIRUS BY ACETYLETHYLENEIMINE AND BY COMBINED EFFECT OF ULTRAVIOLET LIGHT AND β-PROPIOLACTONE. Fellowes, O. N. (Plum Island Animal Disease Lab., Greenport, N. Y.). J. Immunol., 95: 1100-6(Dec. 1965).

The effect of uv irradiation was tested on foot-and-mouth disease virus (FMDV), type A, strain 119, inactivated by acetylethyleneimine (AEI) or β-propiolactone (BPL) at a chemical concentration of 0.05% and a temperature of 23°C. AEI completely inactivated the virus under these conditions while BPL did not, leaving active virus in the mixture. To eliminate the tailing-off effect in the inactivation of virus, active virus in a thin film was treated with uv at 48 $\mu w/cm^2$ of surface for either 10, 15, or 20 min, followed by exposure of the virus to 0.05% BPL at 37°C for 15 min. This combined treatment completely inactivated the virus even at the shortest exposure time to uv. The immunogenicity of the two products, prepared by AEI and BPL as described, was preserved to about the same degree when tested in adult mice and chickens. The combination of uv and BPL used to inactivate all the virus in the preparations was successful as tested in mice and tissue culture. Exposure of virus to uv in a thin film for periods of time beyond 20 min was harmful to the antigenicity of the final product. The data also indicated that uv alone might convert FMDV to an immunogenic preparation of some value. (BBB)

11148 EFFECT OF MICROWAVES ON OPALINA RANARUM. Ismailov, E. Sh. Vestn. Leningr. Univ., Ser. Biol., 2: No. 9, 147-9(1966). (In Russian).

In view of the scarcity of available information on the effect of the UHF field (microwaves) at the cellular level, the author developed a method which makes it possible to investigate the viability of the cell throughout the time of its exposure to the biological effect of microwaves until its death. Using an experimental device assembled from a KG-54-A generator supplying microwaves to a waveguide-type measuring line housing the miniature bath in which the cell is placed, he investigated the dynamics of the effect of a UHF field on the cells of the infusorian, Opalina

ranarum, a frog parasite. The capacitance of the cells was measured by implanting one of the electrodes (microelectrode) directly in the cell with the aid of a stereotaxic apparatus and applying the other electrode to the cell from the outside; this operation was performed under a binocular stereoscopic microscope. Capacitance of the cells of Opalina ranarum was found to vary with cell size and at a frequency of 0.4 mega-cps it averages 40-60 micromicrofarads; it decreases with increasing time of exposure to the UHF field, until it finally disappears when the cell dies (at the 7th or 8th minute when the standing wave is at its maximum (λ = 7.6 cm). The relationship between the lethal UHF power threshold and the time of exposure obeys Nernst's law: $P\sqrt{t}$ = const, where P is the power of the UHF field and t is the time of exposure. There is also a definite relationship between the decrease in the capacitance of the cells of Opalina ranarum and the time of exposure to microwaves, and a corresponding formula is derived on this basis; this formula and method may, incidentally, also be employed to trace the dynamics of the effect of not only microwaves but also other agents destructive to the cell (poisons, etc.). (JPRS)

11149 PROTECTING CHICKENS FROM CECAL COCCIDIOSIS WITH IRRADIATED OOCYSTS. Mladenovic, Z.; Sibalic, S.; Slavica, M. (Veterinary Coll., Belgrade. Veterinary Inst., Zemun, Yugoslavia). Vet. Glas., 20: 527-30(1966).

Inoculation of 5 to 100M oocysts of Eimeria tenella previously irradiated with 10M to 25MR, challenge with 200M normal oocysts: results inconclusive. (JPRS)

11150 RUBY LASER AS A MICROSURGICAL INSTRUMENT. Saks, Norman M. (New York Univ., New York); Roth, Charles A. Science, 141: 46-7(July 5, 1963).

A low-power ruby laser, integrally mounted with a triocular biological microscope that permitted precise positioning of the laser beam on specimens, was used to induce morphological changes at the cellular level in Spirogyra. The laser had a max output of 20 mJ (pulse duration 500 μsec). Experiments indicated that, unless relatively high beam energies were used, the laser beam passed through the cell wall without causing any visible effects. When methylene blue chloride was applied to the cell wall, a large reduction in beam energy was permitted and burn effects were confined to a localized area. This permitted puncturing of the cell wall of Spirogyra. The full energy of the laser beam focused on the cell wall caused a disruption of the target cell and affected adjacent cells. Cell walls were split and nuclei and chloroplasts were ejected into the surrounding medium. Smaller beam energies caused brown or blackened areas about 25 μ in dia. Cytoplasmic material formed a plug and closed the burned area. The chloroplast and cytoplasm in the burned area became coagulated and globular. The single nucleolus in the nucleus became hyaline. When the chloroplast helix in the cell was subjected to beam energies ranging from 0.3 to 0.61 mJ per pulse, coagulation of the chloroplast and cytoplasm occurred along with loss of turgor pressure in the cell. Specific portions of the cell could be subjected to low levels of energy without much damage other than to the immediate area. (BBB)

11151 RESULTS OF A STUDY OF THE EFFECTS OF COSMIC RADIATION AND OTHER SPACE FLIGHT FACTORS ON LYSOGENIC BACTERIA AND HUMAN CELLS IN CULTURE. Zhukov-Verezhnikov, N. N.; Mayskii, I. N.; Pekhov, A. P.; Rybakov, N. I.; Dobrov, N. N.; Antipov, V. V.; Kozlov, V. A.; Saksonov, P. P.; Podoplelov, I. I. Izv. Akad. Nauk SSSR, Ser. Biol., No. 4, 592-3(1966). (In Russian).

Cultures of lysogenic bacteria (E. coli K-12) and normal and cancerous human cells were exposed to the effects of space flight aboard Vostok-3, Vostok-6 and Voskhod-1 spacecraft. A slight but significant increase in the induced phage production was observed in the case of the bacteria in comparison with earth-bound controls. No clear relationship between this effect and the duration of space flight was observed. In the case of human cells the cultures exposed to space conditions for a second time showed a cumulative effect expressed by a longer latent period in growth capacity restoration and other characteristics in comparison with similar cultures exposed once or with earth-bound controls. However, no essential differences between these cells and the controls were reliably observed. (JPRS)

11152 MULTIPLICITY REACTIVATION OF REOVIRUS PARTICLES AFTER EXPOSURE TO ULTRAVIOLET LIGHT. McClain, Mary E.; Spendlove, Rex S. (California State Dept. of Public Health, Berkeley). J. Bacteriol., 92: 1422-9(Nov. 1966).

Exposure of reovirus suspensions to moderate doses of ultraviolet light results in essentially exponential inactivation of infectivity to survivals of 10^{-2} to 10^{-3}. With suspensions of sufficiently high particle concentration, larger doses of ultraviolet light (6 to 12 min) are associated with multiplicity reactivation (MR) which is demonstrable both by immunofluorescent-cell count and by plaque assay in FL human amnion cells. Similar effects are produced by photodynamic inactivation in the presence of proflavine, but not by thermal inactivation at 50°C. All three reovirus types exhibit MR under appropriate conditions, and all three interact in mixed ultraviolet suspensions with high efficiency. Progeny from FL cells infected under conditions of MR were as infectious as those of unirradiated inocula, with yields per cell ranging from 10^4 to 4×10^4 infective units. (auth)

11153 ULTRAVIOLET RAYS AS ONE OF THE POSSIBLE FACTORS RESPONSIBLE FOR THE LOSS OF VIRULENCE OF TUBERCLE BACILLI. Tsuzuki, M.; Obayashi, Y.; Iwasaki, T. (Japan Anti-Tuberculosis Association, Tokyo). Bull. Int. Union Tuberc., 35: 315-24(Sept. 1964).

Human and bovine types of tubercle bacilli were found to be more sensitive to uv rays than the avian type, atypical mycobacteria, and acid-fast saprophytes. Among the human types of tubercle bacilli tested, newly isolated and virulent tubercle bacilli were more sensitive than stock strains which were more or less attenuated. As to the bovine type, Ravenel strain was far more sensitive to uv than BCG. By the repetition of uv irradiation and recovery, the resulting strains of tubercle bacilli were found to become less sensitive to uv irradiation than the original nonexposed strains. The strains exposed to repeated uv irradiations were found to be of decreased virulence as compared with that of the original nonexposed strains. From a practical viewpoint, these phenomena suggest the possibility that they might have some relation to the tendency of virulence to decrease in stock cultures of tubercle bacilli transplanted many times in the laboratory. The authors consider that more attention must be paid to the treatment of stock strains so as to avoid the effect of light. (BBB)

11154 EFFECT OF VISIBLE LIGHT ON MICROORGANISMS. PART II. EFFECT OF VISIBLE LIGHT ON THE GROWTH OF YEAST, ASPERGILLUS NIGER AND A. ORYZAE, ALCOHOLIC FERMENTATION, CITRIC ACID FERMENTATION, FORMATION OF α-AMYLASE AND EFFECT OF PREIRRADIATION BEFORE ULTRAVIOLET IRRADIATION. Takami, Wataru (Waseda Univ., Tokyo). Hakko Kyokaishi, 23: 270-6(1965). (In Japanese).

The effect of preirradiation with visible light before uv irradiation on the survival rate of yeasts was studied. A small quantity of yeast spores was suspended in 50 ml sterile water and the concentration of spores were measured with a hemocytometer. One or 2 ml of yeast cell suspension in 100 ml water was placed on a petri dish and preirradiated with 0, 2000, or 4000 lux at 30°C for 4.5 to 6 hr (6 hr for A. niger, 4.5 to 5 hr for A. oryzae). Then, the covers of petri dish were removed and the cells irradiated with a uv lamp (10 w, 100 v, 2537 Å) in a dark room at 30°C, with the lamp 25 cm from the samples. For A. niger the irradiation time was 0, 10, 15, 20, 25, and 30 min and for A. oryzae 0, 1, 2, and 3 min. After irradiation, 0.025- or 0.5 ml samples were distributed on Pfeffer agar culture contained in a petri dish and incubated at 30°C for 2 to 3 days. The number of colonies was counted and the survival rate measured. The survival rate was increased with the pretreatment by visible light and this effect was greater in A. oryzae than A. niger. The activity of the spores was considered to be increased by the pretreatment of visible light and its resistance to uv was increased. (BBB)

11155 FISSION OF VIRUS UNDER ELECTRON BOMBARDMENT. Jacob, L. Int. J. Electron., 21: 137-51(Aug. 1966).

A thoriated tungsten point emitter was used to detect the existence of single atoms and atom complexes produced as the result of electron bombardment of virus particles. It is considerably more sensitive than pure tungsten when thermal annealing techniques involving the diffusion of thorium over grain boundaries and surface are applied; the work function depends on the time of annealing and there is a "sensitive time" when the surface is most active as a detector. For optimum conditions an activation energy of 0.22 eV/atom is indicated for the diffusion and re-arrangement processes occurring on the surface. Using a rough criterion for size—recovery time varies as $(\text{mass})^{-\frac{1}{2}}$; the virus splits into fragments, the largest of which is a few hundred angstroms in size, while others have average masses between 30 and 130 times the mass of the oxygen atom. In addition, the protein environment disintegrates into spasmodic, spontaneous cascades of single atoms, presumably C, N, O, which appear to be highly localized on the target. The mechanism of fission arises from the breaking of bonds in the protein matrix by energy received from the secondary electrons produced by electron bombardment. The secondary emission ratio for skin cells is of order 12 and the secondary current is oscillatory in character. This is mainly attributed to the modulation of secondary current by the positively charged fission products released; other factors contributing are (1) shock excitation of the lattice by secondaries, (2) coulomb interaction between "residues" and the negative charging up of

isolated areas of the proteins, (3) coupling and "resonance absorption." It is noteworthy that the frequency of release of atom complexes and that of the secondary current are of the same order and is in the acoustic range. (auth)

11156 EFFECTS OF MAGNESIUM DEFICIENCY IN ESCHERICHIA COLI B ON THE BEHAVIOR OF INFECTIOUS COMPLEXES E. COLI B/PHAGE T2. Bourgaux, P.; Bourgaux-Ramoisy, D. (Univ. Libre, Brussels). Ann. Inst. Pasteur, 104: 746-55(June 1963). (In French).

Inactivation by uv light and photoreactivation of phage T_2 were studied in magnesium-deficient E. coli B. In cultures of E. coli B in the exponential phase, magnesium deficiency induces the disappearance of ribosomes, a reduction of protein synthesis, and arrest of growth. After 24 hr the number of ribosomes drops to 5% of the normal value. The multiplication of phage T_2 in magnesium-starved bacteria is slowed down, perhaps by diminished burst size. However, upon transfer to normal medium every infectious unit produces phage. The development of resistance to uv-inactivation of phage in magnesium-starved bacteria proceeds normally, as is the case for the photoreactivation of uv-inactivated phage. Magnesium-deficient bacteria inactivated by uv irradiation are reactivated by visible light and permit multiplication of intact phage at the same rate as control bacteria. The disappearance of ribosomes does not interfere with the initial stages of phage development; the maturation phase seems to be affected, probably by interference with vital protein synthesis processes. Although magnesium deficiency decreases the number of ribosomes, the RNA content of the cells does not appear to be diminished. (BBB)

11157 DEVELOPMENT OF SOILS UNDER THE EFFECT OF GAMMA IRRADIATION. Boyer, Jean (Centre de Recherches et d'Experimentation de Genie Rural, Antony, France); Combeau, Andre; Grauby, Andre; Thomas, Anne-Marie. Bull. Inform. Sci. Tech. (Paris), No. 106, 39-55(July-Aug. 1966). (In French).

After the irradiation of soils from different origins in the swimming-pool pile Triton (gamma flux of 4 mrad), changes were observed in some of the chemical, physical, biological, and agronomical properties. The microflora was destroyed completely, and the supply of biogenic elements to plants (cultivated later) increased significantly in the first stage at least. A corresponding reduction in structural stability was found in the irradiated soils; the Atterberg limits were displaced, and the pH sometimes seems to decrease. Above all, however, the composition of extractable organic substances was greatly modified by a spectacular rise in value of the fulvic acid fraction. (auth)

11158 RADIATION STUDIES OF AVIAN TUMOR VIRUSES AND OF NEWCASTLE DISEASE VIRUS. Levinson, Warren; Rubin, Harry (Univ. of California, Berkeley). Virology, 28: 533-42(Apr. 1966).

The x-ray and uv sensitivity of various virus strains was examined. The infectivity of several strains and pseudotypes of Rous sarcoma virus (RSV) was about 20 times more resistant to inactivation by uv radiation than the infectivity of several strains of Newcastle disease virus (NDV). The infectivity of Rous-associated virus (RAV) and the ability of RAV to activate RSV were inactivated by uv radiation at the same rate as the infectivity of RSV. X rays inactivated the infectivity of NDV, RSV, and RAV and the activation of RSV by RAV at the same rate. Since the sensitivity to uv of two strains and several pseudotypes of RSV is the same, changes in the RNA and in the protein coat which are sufficient to produce strain differences, and changes in the protein coat which characterize the different pseudotypes do not affect the uv sensitive target within these viruses. These experiments provided no evidence that the RSV genome in cells can rescue a uv-damaged RAV genome. A comparison of the intrinsic sensitivities of RSV and NDV with the intrinsic sensitivities of other animal, bacterial, and plant viruses is made. (BBB)

11159 EFFECT OF ROUTE OF ADMINISTRATION OF VACCINE AND CHALLENGE ON THE IMMUNOGENIC EFFICIENCY OF DOUBLE VACCINATION WITH IRRADIATED ANCYLOSTOMA CANINUM LARVAE. Miller, T. A. (Univ. Coll., Nairobi, Kenya). J. Parasitol., 50: 200-6(Apr. 1965).

Treatment of the infective larvae of A. caninum with x rays produces a characteristic attenuation, which can be demonstrated by a reduction in the infectivity of the larvae, as measured by adult hookworm establishment in the intestine of the host, by a reduction in pathogenicity of the resultant burden, and by a sterilizing effect on the female worm at levels of larval irradiation of 40 kR or greater. A single subcutaneous infection with 1000 40-kR-irradiated larvae conferred highiy significant resistance to a subsequent challenge of normal larvae. Double subcutaneous vaccination with 40-kR-irradiated larvae is more than twice as effective as single vaccination. Experiments were conducted on the immunogenic efficiency of irradiated vaccine when the route of administration of vaccine and challenge larvae was varied. Double subcutaneous vaccination of pups aged 3 and 4 months with 1000 40-kR-irradiated larvae is more effective than double oral vaccination with the same preparation when resistance is measured by the establishment of adult hookworms resulting from an experimental challenge of normal larvae. In terms of resistance to the pathogenic effects of the challenge, as demonstrated by hematologic and coprologic findings and by clinical observation, both methods of vaccination are equally effective in protecting the vaccinates when compared with the severely affected challenge control dogs. The arrest of x-irradiated larvae in some somatic location on their migratory route following subcutaneous inoculation seems to produce a better immunogenic stimulation of the host. (BBB)

11160 EFFECTS OF EXTRACTS OF IRRADIATED POTATOES ON THE GROWTH OF MICROORGANISMS. Dupuy, P.; Usciati, M. (Institut National de la Recherche Agronomique, Versailles). Radiat. Bot., 6: 49 -503(Dec. 1966). (In French).

The growth of Escherichia coli was determined in nutrient broth supplemented with extracts of irradiated and non-irradiated potatoes. The extracts of untreated potatoes have an inhibiting effect that disappears when the tubers have just begun to sprout. Irradiation (10 to 50 Krad) of potatoes at different times of storage progressively increases this inhibition that disappears to a great extent in sprouting tubers because, at this stage, substances activating the growth of microorganisms are produced. (auth)

11161 METHOD OF DETECTION OF BACTERIAL MUTATIONS INDUCED BY COSMIC RAYS. Atlan, H.; Deltour, G.; Loubiere, R. Rev. Med. Aeron. (Paris), 4: 37-9(3rd Quarter 1965). (In French).

Primary galactic cosmic radiations (90% protons, 7 to 9% α particles, and 1 to 3% of heavy ions, all with energies of ~1 BeV per nucleon) have been found capable of inducing mutations. Accelerators are not effective in producing heavy ions (Z = 6 to 26) so that cosmic rays are the only feasible source of these ions at present. Problems encountered in testing the mutagenic action of such ions at high altitudes are discussed preliminary to a report of results from three high-altitude balloon flights. These flights reached 27,000 to 33,000 m and provided two- to three-hr exposures at max altitude. Four different strains of Escherichia coli were flown for detection of mutagenic effects of cosmic rays. The results obtained were incomplete and inconclusive because of the short exposures and problems in dosimetry. The survival and mutation levels of the bacteria were similar in exposed and control cultures. Attempts to record the trajectory of heavy particles in the cultures with photographic emulsions and to relate this to mutant colonies was not altogether successful. Longer exposures, by cultures sent aloft in satellites, will be required for more definitive results. (BBB)

Radiosterilization and Radiopreservation

Refer also to abstracts 10516 and 10549.

11162 (UCD-34P73-11) THE RADIATION PHYSIOLOGY AND MICROBIOLOGY OF FRUIT DETERIORATION. Progress Report, January 1, 1964–December 31, 1966. Sommer, N. F.; Bradley, Muriel V.; Buckley, Patricia M. (California Univ., Davis. Dept. of Pomology). Contract AT(11-1)-34. 137p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress is reported on the following studies: recovery of Rhizopus stolonifer sporangiospores after potentially lethal gamma irradiation; an oxygen-dependent postirradiation restoration of Rhizopus stolonifer sporangiospores; prevention of repair in irradiated Rhizopus stolonifer sporangiospores by inhibitors of protein synthesis; comparisons of metabolic recovery among fungi following spore injury by gamma irradiation; effects of chemical protection on repair of potentially lethal irradiation injury in Rhizopus stolonifer sporangiospores; electron microscopy of Botrytis cinerea conidia; electron micrographs of dormant and germinating conidia of Botrytis cinerea; some ultrastructure features of nuclei in germinating Rhizopus stolonifer sporangiospores; electron micrographs of germinating sporangiospores of Rhizopus stolonifer; quantitative dose response of Prunus fruit decay fungi to gamma irradiation; sensitivity of Citrus fruit decay fungi to gamma irradiation; ionizing radiation for control of postharvest diseases of fruits and vegetables; recent research on the irradiation of fruits and vegetables; radiation-heat synergism for inactivation of market disease fungi of stone fruits; inactivation of Rhizopus stolonifer sporangiospores by chilling temperatures; effect of gamma radiation on rate of ethylene and carbon dioxide evolution by lemon fruit; effect of gamma radiation on Shasta strawberries under marketing conditions; studies on radiation-induced ethylene production by lemon fruits. (H.L.W.)

11163 LIPID OXIDATION IN IRRADIATED COOKED BEEF. Greene, Barbara E.; Watts, Betty M. (Florida State Univ., Tallahassee). Food Technol., 20: 111-14(Aug. 1966).

Experiments were conducted on 0.5- and 4.8-Mrad irradiated ground beef, ham, and chicken to examine the nature of the oxidation processes occurring in the irradiated lipid components. Lipid oxidation in cooked meat exposed to air was found to be inhibited by radiation sterilization. Oxidation was measured by the thiobarbituric acid (TBA) test for malonaldehyde and by manometric studies. This inhibition became more pronounced when the samples were stored in sealed cans at room temperature before exposure to air. Higher radiation doses produced lower TBA numbers. Added malonaldehyde disappeared during storage in sealed cans, suggesting further reaction of this compound. Spectrophotometric evidence was presented for the formation of a colored Maillard-type product between lysine and malonaldehyde in model systems. The results indicate that the low TBA numbers found in stored cooked irradiated meat are due to a combination of antioxidant development and further reaction of oxidation products. Results on storage experiments with pork and chicken were similar to those with beef. While the TBA numbers of irradiated pork and chicken were higher than those of beef, the unirradiated controls were also higher. (BBB)

11164 IONIZING RAYS PROLONG THE USEFULNESS OF FOODSTUFF. Fleischermeister, No. 2, 47(1966). (In German).

The usefulness of foodstuff can be prolonged with small doses of rays, primarily gamma rays which induce little or no radioactivity. The radiation is applied to the surface or beyond the surface, depending on the type of foodstuff. The preservative effect sets in without a rise in temperature so that the foodstuff freshness is retained. The ionizing rays kill microbes, molds and insects, prevent the germination of potatoes, affect the ripening process of fruit, preserve mushrooms, bacon, French fries and fresh fish, and control salmonella infections in eggs, meat, and fish. The small doses of radiation used in the sterilization and pasteurization of foodstuff have not produced any toxic or cancer-inducing substances and there is no evidence that the irradiation has an unfavorable effect on the foodstuff. The nutritive value of foodstuff is only slightly affected by the irradiation (destruction of vitamins K and E) while its other qualities are the same as in heat-treated foods. (JPRS)

11165 INVESTIGATIONS INTO THE CAUSES OF COLOR CHANGES IN IRRADIATED MEATS. Mirna, A.; Gruenewald, T. (Bundesanstalt fuer Fleischforschung, Kulmbach, Ger.). Fleischwirtschaft, 16: 196-8(Mar. 1964). (In German).

Studies were conducted on the chemical changes associated with color changes in irradiated meat. Pork meat, packaged in polyethylene, was irradiated by 60-kv x rays and 1-MeV electrons to doses up to 3 Mrad. By extraction of meat, irradiated with doses of 0.10 Mrad and higher, it was possible to detect formation of nitrite. Nitrite formation was dose dependent up to 1-MeV doses. At 1 MeV the nitrite disappeared from meat about 3 days after irradiation, but was still present at 5 days after lower doses (0.1 Mrad). Since it is possible that nitrite could react with myoglobin in meat to form nitrosomyoglobin, attempts were made to detect this substance spectrophotometrically in acetone extracts of irradiated meats. However, results were negative. Possible ways in which nitrite could form in irradiated meat are discussed. (BBB)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 12142 and 12231.

11166 (BNL–50021) HIGH-TEMPERATURE LIQUID-METAL TECHNOLOGY REVIEW. A Bimonthly Technical Progress Review. Volume 4, Number 4. (Brookhaven National Lab., Upton, N. Y.). Aug. 1966. Contract AT(30-2)-Gen-16. 62p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Reviews are presented of current topical and progress reports in the field of high-temperature liquid-metal technology. The reviews cover the following subjects: materials development, corrosion and mass transfer, heat transfer, fluid dynamics, instrumentation, purification, component development, physical properties, thermodynamics, chemical analysis, and power systems. The reports reviewed are from programs for the development of power systems for space vehicles and of fast breeder reactors. (D.L.C.)

11167 (BNL–50030) HIGH-TEMPERATURE LIQUID-METAL TECHNOLOGY REVIEW. A Bimonthly Technical Progress Review. Volume 4, Number 5. (Brookhaven National Lab., Upton, N. Y.). Oct. 1966. Contract AT(30-2)-Gen-16. 50p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A total of 22 reviews is presented of reports and papers dealing with developments in high-temperature liquid-metal technology. Among the topics covered are heat transfer, fire hazards, mass transfer, cavitation, and carbon metering. Graphs of data are included. (D.L.C.)

Corrosion and Erosion

Refer also to abstracts 10783, 11190, 11208, 12141, 12181, and 12236.

11168 (ACNP–66542) ELK RIVER REACTOR OPERATIONS ANALYSIS PROGRAM FINAL REPORT: TASK 615. CORROSION SAMPLES AND TESTS EVAPORATOR WATER BOXES. Bergen, C. R. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). June 1966. Contract AT(11-1)-1357. 34p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Type 304 stainless steel coupons and "U-bend" test samples were exposed to the wet steam–water environment within the evaporator water boxes of the Elk River Reactor. Results of evaluation of the test probes after 22 months exposure are presented. Small corrosion rates of as-rolled and annealed specimens were found. Some intergranular attack of the sensitized coupons showed up during this period. All "U" bend samples exhibited stress corrosion cracking. (auth)

11169 (AECL–2640) SOME ASPECTS OF MATERIALS IN ORGANIC COOLED REACTORS. A Summary of Canadian Experience. Boulton, J. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). May 1966. 11p. Dep. mn. AECL $0.50.

The results of development work on the use of SAP and zirconium alloys in organic coolants are summarized. Most attention is given to the behavior of zirconium alloys since these are at present being used for fuel cladding and pressure tubes in the WR-1 organic cooled reactor. The operating life of zirconium alloys as a fuel cladding and pressure tube material is discussed and future developments which may extend the useful life of these alloys indicated. Some brief comments are made on stress corrosion cracking of stainless steel in chlorine contaminated coolant. (auth)

11170 (BNL–10800) CORROSION BY THE ALKALI METALS. Weeks, J. R.; Klamut, C. J.; Gurinsky, D. H. (Brookhaven National Lab., Upton, N. Y.). [1966]. Contract AT(30-2)-Gen-16. 13p. (CONF-661110–7). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna, Austria.

A review is presented of the state of the art of corrosion testing of materials by the alkali metals, the models proposed to explain the observed corrosion results, and the status of materials selection for application in alkali metal-cooled systems. Studies and the liquid metal-cooled reactors in operation demonstrate that stainless steels can be considered for structural and cladding applications below 650°C. Corrosion models are reviewed and their inability to explain all the experimental observations discussed. An alternate model is proposed which qualitatively is in agreement with experimental observations. In this model, the rate controlling step is either the surface reaction of Fe with "available oxygen" (dissolved Na_2O) to form an Fe-O-Na complex or the rate at which "available oxygen" can reach the surface to form the complex; which process is rate controlling depends on the temperature, Na velocity, and oxygen concentration in the Na. The solution chemistry of O_2, C, and alkali metal-oxygen-transition metal complexes dissolved in the alkali metals is reviewed. "Molecular" complexes appear unlikely to exist in solution in the alkali metals, although the thermodynamic tendencies for them to form suggest that stable bonds exist in solution between O_2, the transition, and the alkali metals. The insolubility of C in "oxygen-free" Na indicates that C transfer may be associated with O_2 in Na down to very low oxygen levels, although experimental data do not generally confirm this postulate. Corrosion of refractory metals by boiling alkali metals at temperatures above 1000°C is markedly affected by impurities in either the liquid or refractory metal; the addition of Ti, Zr, or Hf as "getters" to the refractory alloys and proper heat treatment to react the "getter" addition with O_2, N_2, C, and H_2 in the alloys are required to prevent their corrosion by the alkali metals at these temperatures. (auth)

11171 (CONF-660802–3) THE COMBUSTION OF BULK BERYLLIUM METAL IN THE H_2–O_2–H_2O SYSTEM. Blumenthal, J. L.; Santy, M. J. (TRW Systems, Redondo Beach, Calif.). Apr. 1, 1966. 25p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 11th International Symposium on Combustion, Berkeley, Calif.

Results are reported of investigations on the kinetics of the high temperature exothermic reaction of bulk Be with the combustion gas species H_2, O_2, and water vapor. The studies included both quantitative investigations of the rate of reaction of Be with H_2, O_2, and H_2O; and qualitative observations of the behavior of Be in H_2-O_2 flames which were thermochemically defined. It was found that flame environments which contained high concentrations of both water vapor and O_2 (oxygen-rich H_2-O_2 flame) reacted much more violently with Be than flame environments in which water vapor was the only reactive species or flames in which O_2 was the only rapidly reacting specie. In O_2-rich flames in which both H_2O and O_2 were present in significant concentrations, the Be samples were found to ignite and burn with a very hot vapor phase diffusion flame under all but the lowest initial heat flux conditions. Samples were ignited under conditions in which the thermal balance, excluding the energy generated by chemical reaction, would leave the sample at a steady state temperature below the Be melting point (1284°C). (auth)

11172 (COO–1319–46) POLARIZATION CHARACTERISTICS OF HIGH PURITY NICKEL-HIGH IRON–CHROMIUM–NICKEL ALLOYS IN SULFURIC ACID SOLUTIONS. Condit, D. O.; Staehle, R. W. (Ohio State Univ. Research Foundation, Columbus). Sept. 1966. Contract AT(11-1)-1319. 63p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Potentiokinetic experiments were conducted to determine the anodic and cathodic polarization behavior of high-Ni ternary Fe–Cr–Ni alloys. All data were obtained ~1N H_2SO_4 at 25°C. Cr additives tended to shift the entire anodic curve in the active (negative) direction. Ni tends to shift the anodic curve in the noble (positive) direction. A general plateau region was observed for corrosion potential values as composition tends toward pure Ni. (auth)

11173 (EURAEC–1725) FURTHER DEVELOPMENT OF THE $ZrNb_2Sn$1 ZIRCONIUM ALLOY, WITH REFERENCE TO ITS USE FOR CLADDING IN WATER-COOLED REACTORS. Final Report No. 2. Drefahl, K.; Richter, H.; Ruckdechel, W. (Metallgesellschaft A. G., Frankfurt am Main (West Germany)). June 23, 1966. Contract 019-63-11-TEED. 94p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Work was carried out to improve the properties of the Zr–Nb–Sn alloy by changing its tin content and by adding other alloying elements (Cu, Fe, Cr, Ge, V, Sb, and Te) constituting up to 0.5% of total weight. Corrosion behavior in steam at 400 and 450°C, together with mechanical properties at 450°C, was given special prominence in the investigations. A start was made by investigating the corrosion behavior of 51 alloys. Eleven Zr–Nb alloys to which other elements were added were selected for more detailed investigation. Results showed that the corrosion behavior of the Zr–Nb–Sn alloy in steam heated to 400°C can only be improved to a relatively small extent by changing its composition. A reduction in Sn content induced a considerable improvement in corrosion

properties in steam heated to 450°C. In particular, the addition of Cu, Fe, Cr, or Sb was helpful at these high corrosion temperatures. The percentage of H_2 absorption of ternary Zr–Nb alloys with Fe, Cr, or Sb was found to be particularly low. Unfortunately, a reduction in tin content reduces strength and has an adverse effect on creep behavior. The initial Zr–Nb–Sn has the highest short-time strength. The influence of other additional alloying elements is difficult to ascertain, since the Nb content of the various alloys is varied to give roughly the same absorption cross-section for thermal neutrons. However, it appears that Sb and V additives give higher short-time strengths than Cu, Fe, and Cr additives. Sb and V also have a good effect on creep behavior. The alloys with 1% Sn (by weight) and Fe additives, which show up particularly well in creep tests, failed at high corrosion temperatures. The Zr–Nb–Sb alloy had relatively high elongation values even after corrosion, while alloys containing Fe showed a sharp elongation value drop in steam at 450°C if they had a Sn content of as little as 0.3%. An increase in Sn content intensifies corrosion and reduces elongation still further. (auth)

11174 (RD/B/N-326) AN INVESTIGATION INTO THE EFFECT OF NUCLEAR RADIATION ON THE CORROSION OF MILD STEEL IN CONTACT WITH WET CONCRETE. Rowe, M. D.; Crawford, T. S. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Oct. 1964. 6p. Dep. mn.

It has been postulated that although mild steel embedded in thick concrete structures suffers only slight corrosion, the corrosion rate might be accelerated by free oxygen resulting from the radiolysis of water under a gamma flux. Consequently a series of tests has been undertaken from which it has been found that corrosion of one set of specimens, irradiated in gamma flux, was greater than that of control specimens, but a 1 in. thickness of concrete gave complete protection. (auth)

11175 OXIDE GROWTH AND CAPACITANCE ON PREIRRADIATED ZIRCALOY-2 AND ZIRCONIUM. Davis, R. J. (Oak Ridge National Lab., Tenn.). J. Electrochem. Soc., 114: 124-7(Feb. 1967). (ORNL-P-2363).

Previous work has demonstrated a large enhancement of corrosion of Zircaloy-2 by oxygenated aqueous solution during bombardment by fast neutrons. Measurements of oxide growth and of film impedance were made on specimens preirradiated with fast neutrons in order to determine whether the irradiation damage important to corrosion occurs in the oxide film or in the metal substrate. A small enhancement of corrosion was observed with some specimen pretreatments. Results indicated that some corrosion enhancement resulted from irradiation of the substrate metal and that dissolved oxygen was required for the effect. (auth)

11176 ANODIC OXIDATION OF ALLOYS. Wood, G. C.; Pearson, C.; Brock, A. J.; Khoo, S. W. (Univ. of Manchester, Eng.). J. Electrochem. Soc., 114: 145-8(Feb. 1967).

An investigation was made on anodic film growth on binary alloys between valve metals and metals which do not form this type of film. Experiments were performed using Nb and binary alloys of Nb containing 5, 20, and 50 at. % Zr, Ti, W, V, or Mo. Additional experiments were conducted on Nb–V, Ti–V, Nb–Mo, and Ti–Mo alloys containing 70, 85, or 95 at. % V or Mo. Thick, relatively good quality films were produced on Nb and the alloys containing up to 50 at. % additions, with approximate current efficiencies of 100% at 10 ma/cm^2 and 64 to 72% at 100 μa/cm^2. Results indicated that metals such as Mo and V, which cannot themselves normally be anodized, can be made to produce films by alloying with relatively low proportions of valve metals such as Nb and Ti. The properties of films on metals such as Ti and W can be improved by alloying with metals giving superior films. (J.G.B.)

11177 COMPATABILITY OF U–Pu–Fz FUEL ALLOYS WITH POTENTIAL CLADDING MATERIALS. Walter, C. M.; Lahti, J. A. (Argonne National Lab., Ill.). Nucl. Appl., 2: 308-19 (Aug. 1966).

The cladding materials tested against U–Pu–fizzium alloy are arranged as follows in order of decreasing compatibility at 650°C V–20 wt % Ti, V–10 wt % Ti, Mo, 304 stainless steel, Hastelloy-X, Nb, and Nb–1 wt % Zr. Increasing Pu content of the fuel decreases its compatibility with all the cladding materials investigated. The results indicate that the compatibility of a given metal fuel with various claddings may be predictable, on a relative basis, by comparison of the binary phase diagrams of the major elements in the fuel and in the cladding. (auth)

11178 INFLUENCE OF INCREASING THE COPPER CONTENT ON FORMATION OF AN INTERMEDIATE LAYER AT THE METAL–OXIDE INTERFACE DURING OXIDATION OF ZIRCONIUM–COPPER ALLOYS AT 750 DEG C. De Gelas, B.; Beranger, G.; Marion, C.; Lacombe, P. (Centre de Recherches Metallurgiques et Service Inter-Centre-Microsonde, Paris). J. Nucl. Mater., 20: 337-40(Sept. 1966). (In French).

The oxidation of Zr–Cu alloys containing 1 to 4 wt % Cu was studied under O_2 current at atmospheric pressure and at 750°C Micrographic examinations of the oxided samples showed an intermediate layer with metallic aspects at the metal–oxide interface. The length of the intermediate layer is more marked when the Cu content is highest. Microprobe determinations of the composition of the intermediate layer showed the Zr/Cu ratio of this layer is close to that of the compound designed as Zr_2Cu which constitutes the matrix precipitates. A composition for the intermediate layer was obtained of Zr = 68.6%, Cu = 24.4%, and O_2 = 6%. Studies on the effect of the intermediate layer on the diffusion of O_2 into the metal showed the absence of significant evolution of the kinetics as a function of the growth of the intermediate layer. The results are compared with those obtained by other workers on Zr–Cu alloys under CO_2 and on other alloys under O_2. (J.S.R.)

11179 CORROSION OF MATERIALS BY LIQUID METALS. Champeix, L. (CEN, Saclay, France). Energ. Nucl. (Paris), 8: 471-82(Nov. 1966). (In French).

Liquid metal corrosion includes not only purely chemical phenomena, but also special phenomena of mass transfer related to the solubility nature of the fluid. Different parameters must be taken into account: impurity concentration, the velocity of the fluid, temperature, thermal gradients in the core of the liquid metal, and the geometry of the system. The behavior of various alloys under oxygen, sodium, potassium, lithium, lead, bismuth, and mercury corrosion is studied. (auth)

11180 STUDY OF THE MASS BEHAVIOR OF THE OXIDATION OF TANTALUM. Degreve, F.; Drowart, J. (Univ. Libre, Brussels). pp 204-12 of Journees Internationales d'Etude sur l'Oxydation des Metaux. Brussels, Societe d'Etudes, de Recherches et d'Applications pour l'Industrie, 1965. (In French).

The kinetics of the reaction of Ta with oxygen were studied using a mass spectrometer at temperatures of 1900 to 2900°K and at oxygen pressures of 5×10^{-6} to 6×10^{-5} torr. The volatile oxides formed under these conditions are TaO and TaO_2. The competition between the dissolution of oxygen in the Ta and the volatilization of the oxides leads to the establishment of a steady state for which the rates of formation of TaO and TaO_2 are known as functions of the temperature and the pressure. The rate constants and the activation energies for the formation of TaO and TaO_2 are deduced. (tr-auth)

11181 JOURNEES INTERNATIONALES D'ETUDE SUR L'OXYDATION DES METAUX. 6-7-8 -X - 1965. (International Research Symposium on Oxidation of Metals, October 6, 7, and 8, 1965). Brussels, Societe d'Etudes, de Recherches et d'Applications pour l'Industrie, 1965. 309p. (CONF-651082).

Separate abstracts were prepared for 7 of the 34 papers presented. One paper was previously abstracted for NSA (19:22904). The papers not abstracted concern oxidation of metals not within the scope of NSA, e.g., nucleation in superficial oxide films, halogenation of Cu, and thermodynamic studies of oxidation reactions. (A.G.W.)

For abstracts of individual papers see: 11180 and 11182–11187.

11182 OXIDATION OF NIOBIUM AND OF NIOBIUM COATED WITH ALUMINIUM IN STEAM AND STEAM–AIR MIXTURES. Huijbregts, W. M. M.; Brabers, M. J. (Technological Univ., Delft, Netherlands). pp 61-9 of Journees Internationales d'Etude sur l'Oxydation des Metaux. Brussels, Societe d'Etudes, de Recherches et d'Applications pour l'Industrie, 1965.

The oxidation behavior of pure Nb and of Nb coated with Al was studied in the temperature range of 400 to 600°C in different atmospheres: superheated steam, a mixture of steam and air, and in air. Depending on temperature and on oxidation rate the following oxides were found: NbO, NbO_2 needles, mixtures of NbO_2 and T Nb_2O_5 and a T Nb_2O_5 scale. The NbO_2 phase not only is formed below 500°C and at low oxygen pressures, but also at high oxidation rates in air up to 600°C. The rate of oxidation is determined by the properties of the different oxides. Below 600°C the Nb_2O_5 formed in air is a loose powder and formed in steam and steam + air is a rather dense oxide. The Nb_2O_5 scale flakes off at cooling down to room temperature. The NbO_2 needles furnish a better adherence of oxide to metal than to NbO_2 and Nb_2O_5. This may be due to a network formed by NbO_2 continued in the Nb_2O_5 phase. The rate of oxidation of Al-coated, Nb in steam, steam + air, and air is alike when the temperature does not exceed 600°C. A nonporous layer of $NbAl_3$ gives a reasonable protection. At temperatures higher than 600°C two types of failures have been observed: oxidation of Al between $NbAl_3$ grains and formation of cracks in the $NbAl_3$ layer as a result of diffusion and thermal stresses. Once a crack has reached the metal substrate, oxide is formed between metal and $NbAl_3$ layer. It has been observed that the oxidation resistance is high at tem-

peratures of about 1100°C in air. On cooling, however, cracks are formed, which destroy the oxidation resistance of Al coated Nb. (auth)

11183 OXIDATION OF SUPERHEAT MATERIALS IN STEAM: AUSTENITIC STAINLESS STEELS. Board, J.; Holyfield, G.; Dalley, J. (Atomic Power Constructions Ltd., Hounslow, Eng.). pp 163-73 of Journees Internationales d'Etude sur l'Oxydation des Metaux. Brussels, Societe d'Etudes, de Recherches et d'Applications pour l'Industrie, 1965.

The corrosion in steam of a wide range of potential alloys for use as fuel-element cladding in the superheat elements of the Steam Generating Heavy Water Moderated Reactor (S.G.H.W.R.) have been studied. These include austenitic stainless steels, ferritic stainless steels, and high-Ni alloys. The tests were carried out in atmospheric-pressure steam at 550, 650, and 750°C and also in high-pressure steam at 650 and 750°C. The results for the austenitic stainless steels are reported and include weight gain data to 12,000 hours, detailed metallography, and microprobe analysis. The results show that 20/25/Nb stainless steel is superior to the 18/8 series of stainless steels and would have satisfactory corrosion resistance to steam up to 750°C. The corrosion resistance of the stainless steels is shown to be largely dependent on the fabrication history of the steels and the importance of cold-worked surface layers, grain size, and Cr volatilization from the surfaces during high temperature anneals is demonstrated. (auth)

11184 SOME ASPECTS OF THE OXIDATION OF TANTALUM IN THE TEMPERATURE RANGE 600 TO 950 DEG C. Stringer, J. (Battelle Memorial Inst., Columbus, Ohio). pp 195-203 of Journees Internationales d'Etude sur l'Oxydation des Metaux. Brussels, Societe d'Etudes, de Recherches et d'Applications pour l'Industrie, 1965.

The effect of varying specimen geometry on the oxidation of Ta has been studied at 600, 825, and 925°C. In all cases, the oxidizing atmosphere was dry O_2 at a pressure of close to 400 torr. It appears that, although the scale is formed in compression on the metal surface, tensile stresses develop in the outer layers of the porous detached scale, leading eventually to failure. The origin of the pores and fissures observed in the outer scale layer has been investigated. Lines of pores through the scale appear to form above suboxide platelets. (auth)

11185 REACTION OF WATER VAPOR AND TUNGSTEN. Battles, J. E.; Pierre, G. R. St.; Speiser, R. (Ohio State Univ., Columbus, Ohio). pp 213-21 of Journees Internationales d'Etude sur l'Oxydation des Metaux. Brussels, Societe d'Etudes, de Recherches et d'Applications pour l'Industrie, 1965.

The rates of volatilization of WO_2, $W_{18}O_{49}$, WO_3, and W sheet in atmospheres containing water vapor have been studied in the temperature range 1050 to 1275°C. These rates have been measured as a function of the partial pressure of H_2O and as a function of the oxygen potential, the ratio of p_{H_2O}/p_{H_2}. The rate of volatilization of the oxides of W (in the presence of water vapor) decreases in the order $WO_3 > W_{18}O_{49} > WO_2$. Kinetic mechanisms for the experimental observations are proposed. Finally, mass spectrographic analysis shows that the volatile species has the formula $WO_3 \cdot H_2O$. (auth)

11186 OXIDATION OF TUNGSTEN AT HIGH TEMPERATURES: KINETICS OF THE SYSTEM W–CO_2. Cismaru, D.; Geangu-Moisin, A. (Centrul de Cercetari Chimie-Fizica, Bucharest). pp 222-7 of Journees Internationales d'Etude sur l'Oxydation des Metaux. Brussels, Societe d'Etudes, de Recherches et d'Applications pour l'Industrie, 1965. (In French).

The oxidation of W was studied between 500 and 1100°C in CO_2 at pressures of 0.187, 0.42, and 1 atm. The results indicate that the oxidation is controlled by the equilibrium conditions of the system W + CO_2. The processes follow a parabolic law in the temperature and pressure intervals studied. The rate constants found at the CO_2 pressure of 0.187 atm were used to determine the activation energy. Two values of the activation energy were observed: 45,150 cal/mole between 500 and 800°C and 83,200 cal/mole between 800 and 1100°C. The values of the rate constants are smaller than those obtained by other investigators under similar conditions of temperature and pressure. The rate of oxidation increases with increasing CO_2 pressure. (tr-auth)

11187 THERMODYNAMIC TREATMENT FOR OXIDATION OF METALS TO NONSTOICHIOMETRIC OXIDES. Seiyama, T.; Takeyama, N. (Kyushu Univ., Japan). pp 281-8 of Journees Internationales d'Etude sur l'Oxydation des Metaux. Brussels, Societe d'Etudes, de Recherches et d'Applications pour l'Industrie, 1965.

A thermodynamic treatment is given to the change of free energy in oxidation of metals. The systems examined are the Fe–O, Ti–O, V–O, U–O, Mn–O, Pb–O, and Cr–O systems, many of which show relatively wide nonstoichiometric composition ranges. The evaluated values, including those of stoichiometric and nonstoichiometric oxides, show an empirical trend in which ΔG of MO_x results in a single continuous curve at a constant temperature. An example of application of the treatment is given to VO_x and explained on its catalytic action. Regarding the continuity of the free energy with x, a statistical thermodynamic explanation using a multistep oxidation model is given. (auth)

Preparation and Fabrication

Refer also to abstracts 12165, 12166, 12203, and 12240.

11188 (AECL–2630) LITERATURE REVIEW OF THE WELDING OF 3 1/2 PERCENT AND 9 PERCENT NICKEL STEELS. Watson, M. B. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Sept. 1966. 105p. Dep. mn. AECL $2.00.

Nickel steel (3½ or 9%) can be welded by the shielded metal arc, the submerged arc, or the gas shielded arc welding process. Each process has inherent welding variables and their effect on the impact and tensile properties of these welds are reviewed. Preweld surface preparation, weld preheat and postheat, cooling rate after stress relief, shielding atmospheres, welding costs, and weld quality are also reviewed. Tabulated data are presented on welding parameters and mechanical properties of test welds reported by the cited authors. (auth)

11189 (ANL–7155) METALLURGY DIVISION ANNUAL PROGRESS REPORT FOR 1965. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 298p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Two parts are included on engineering and basic metallurgy. Separate abstracts were prepared for each. (P.C.H.)

For abstracts of individual sections see: 11190 and 11208.

11190 (ANL–7155, pp 1-166) ENGINEERING METALLURGY. (Argonne National Lab., Ill.).

Developments are reported for studies on: engineering metallurgy, including fast-reactor fuel element fabrication, development of Th–U and Th–U–Pu alloys, development of ceramic fuels, irradiation of fuels and structural materials, corrosion-resistant jacketing and structural materials, high-temperature jacket materials, and nondestructive testing; and fast-reactor fuel element development and fabrication, including properties of U–Pu-base metallic fuel alloys, carbide fuels and fuel elements, fast reactor jackets, fast-reactor fuel elements, corrosion in sodium of refractory metal alloys, irradiation of fast-reactor fuel, fuel elements, and structural, and nondestructive tests on experimental fast reactor components. (P.C.H.)

11191 (CONF-661003–13) PLUTONIUM FUEL DEVELOPMENT FOR FAST REACTORS IN THE U.S. Kittel, J. H.; Kelman, L. R.; Handwerk, J. H. (Argonne National Lab., Ill.); Zebroski, E. L.; Baily, W. E. (General Electric Co., San Jose, Calif.); Strasser, A. (United Nuclear Corp., Elmsford, N. Y.). [1966]. Contract W-31-109-eng-38. 21p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From AIME Nuclear Metallurgy Symposium on High Temperature Nuclear Fuels, Delavan, Wis.

The U. S. effort on Pu fuel development covers several broad alternatives. Various ceramic fuel compounds are under study, as well as metallic fuels. The main effort for fast breeder fuels is in UO_2–PuO_2, UC–PuC, and U–Pu alloys. Stoichiometry has been found to strongly affect the physical properties of mixed oxide, with optimum properties appearing in slightly hypostoichiometric compositions. The properties of mixed carbide are also affected by stoichiometry. Slightly hyperstoichiometric compositions have been found to be preferable from the standpoints of better compatibility with cladding materials and minimum fission gas release during irradiation. U–Pu alloys containing Zr are preferred because of their higher melting points and their better compatibility with stainless steel cladding. (auth)

11192 (EURAEC–1693) THE STAINLESS STEEL CLADDING OF HEAVY GAGE STEELS. Quarterly Report No. 8, April 1–June 30, 1966. (Neratoom, N. V., The Hague (Netherlands). Ghent Rijksuniversiteit (Belgium). Soudometal, S. A., Brussels (Belgium)). Contract 008-63-12-TEEB-(RD). 10p. (EUR–2880). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

A satisfactory solution to the problem of stainless steel cladding in a single layer is described. The alloyed flux technique was used. The possibilities of using higher alloyed tapes of grade AISI 309 were also investigated. The results showed that from the deposited metal analysis correction efficiency point of view it is of interest

to provide for alloy elements to be added by tape rather than by flux. A skeleton theoretical diagram for interpreting the cladding tests results is included. (auth)

11193 (GA-7433) CESIUM DEPOSITION ON STAINLESS STEEL. Milstead, C. E.; Zumwalt, L. R. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Sept. 1, 1966. Contract AT(04-3)-167. 15p. (CONF-661001-42). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 14th Conference on Remote Systems and Technology, Pittsburgh, Pa.

The deposition of Cs on type-304 stainless steel was measured in vacuo using ^{137}Cs-tagged cesium. Measurements were made at 660 to 1350°F over a Cs pressure range of 2×10^{-9} to 1×10^{-6} atm using specimens that were vacuum baked at temperatures ranging from 650 to 1870°F for 18 to 90 hours. Sorption isotherms were characterized by an empirical isotherm that showed a linear variation of log P_{Cs} with surface coverage and the heat of sorption decreased linearly with coverage. Cs plateout levels range from 0.5 monolayers (based on the geometric surface of the specimen) on very clean surfaces to 90 monolayers on surfaces that were slightly oxidized. The amount of Cs deposited is shown to be directly related to the temperature and duration of the bakeout period. Isosteric heats of sorption vary from about 4 to 80 kcal/mole over the range of coverage. (auth)

11194 (INR-728/XIV/R) SOME COEXTRUSION EXPERIMENTS OF ALUMINIUM CLADDED CERMETALLIC CORE RODS. Rutkowski, W.; Szteke, W.; Wieczorkowski, M. (Institute of Nuclear Research, Warsaw (Poland)). June 1966. 18p. Dep.

Work was done on coextrusion of metallic tubes with metallic and ceramic powder cores. Al was used as cladding material and Al, Mg, Cu, and Al_2O_3 powders and their mixtures were used as core material. Results are presented. (auth)

11195 (INR-749/XIV/PS) SOME PROBLEMS CONNECTED WITH Nb_3Sn COATINGS ON Nb AS MATERIALS FOR SUPERMAGNET ELEMENTS. Rutkowski, W.; Horubala, Z. (Institute of Nuclear Research, Warsaw (Poland)). Sept. 1966. 28p. Dep.

A method was developed for production of Nb_3Sn-coated Nb strips. Results, as well as metallographic, roentgenographic, and microhardness data of the Nb-Sn diffusion layers, are given. (auth)

11196 (IS-T-129) PREPARATION OF URANIUM METAL BY CARBON REDUCTION OF URANIUM DIOXIDE. Strain, Robert V. (Ames Lab., Iowa). Nov. 1966. Contract W-7405-eng-42. 81p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The carbon reduction of UO_2 to U metal using Y_2O_3 crucibles was investigated. The experiments were carried out under vacuum in an induction furnace employing a graphite susceptor. Under these conditions the reduction of UO_2 to metal appeared to take place in three steps: $UO_2(s) + 2C(s) \rightarrow \frac{1}{3} UO_2(s) + \frac{2}{3} UC(s) + \frac{4}{3} Co(g)$ in the temperature range from 1400 to 1600°C; $\frac{2}{3} UC(s) + \frac{1}{3} UO_2(s) \rightarrow UO_{0.5}C_{0.5}(s) + \frac{1}{6} CO(g)$ between 1800 and 1900°C; and $UO_{0.5}C_{0.5}(s) \rightarrow U(l) + \frac{1}{2} CO(g)$ between 1950 and 2100°C. Metal yields near 92% were obtained consistently from these reductions. This metal contained about 2500 ppM C and 500 ppM O_2. However subsequent treatments in which the metal was stirred and then held just above its melting point reduced the C content in up to 80% of the ingot to less than 600 ppM C and less than 100 ppM O_2. (auth)

11197 (KFK-404) DAS ELEKTRONENSTRAHLSCHWEISSEN UND SEINE ANWENDUNG IN DER REAKTORTECHNIK. (Electron Beam Welding and Its Application in Reactor Technology). Scheibe, Willy (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Feb. 1966. 36p. (In German). Dep. mn.

The specifications for welds in reactor technology are briefly indicated and the weldability of the construction materials is discussed. The principle of electron beam welding is discussed and an electron beam welding installation is described. The uses of electron beam welding in the fabrication of components for fast breeder reactors are described, and welding of Ni-containing and Ni-base alloys, Ni-Cr alloys, Mo alloys, and V alloys is illustrated by examples. (J.S.R.)

11198 (LA-3621) PREPARATION OF A PLUTONIUM-0.4 WT. PERCENT THULIUM ALLOY ON A MULTIKILOGRAM SCALE. Harbur, D. R.; Anderson, J. W.; Maraman, W. J. (Los Alamos Scientific Lab., N. Mex.). Sept. 1966. Contract W-7405-eng-36. 10p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Alloying and casting procedures developed for producing a homogeneous Pu-0.4 wt % Tm alloy are described. The procedures are also adaptable for preparing most Pu-base alloys. The alloying time necessary to make a homogeneous Pu-0.4 wt % Tm alloy can be lowered from several hours to less than 30 min by using a dash-pot stirring unit. To avoid macrosegregation of Tm in the casting, the alloy is chill cast into a mold at ambient temperature. (P.C.H.)

11199 (NP-16451) BI-MONTHLY PROGRESS REPORT NO. 2 [ON SOLID SOLUTION STRENGTHENED HIGH PURITY BERYLLIUM ALLOY SHEET], AUGUST-SEPTEMBER 1966. Letter Report. Meyer, G. E. (Beryllium Corp., Reading, Pa.). Oct. 31, 1966. Contract NOw-66-0563-c. 8p. CFSTI $3.00 cy, $0.65 mn.

Extruded Be-Cu alloy slabs were evaluated to ascertain suitable processing temperatures and to determine the intrinsic behavior of the alloys. The slabs were found to exhibit significant elongations in the transverse direction at temperatures from 1200 to 1400°F. Large grains were found in the microstructure of the extrusions and may cause abnormal effects during future processing. Special care was required in machining the alloy extrusions to prevent crack patterns from developing. (P.C.H.)

11200 (RFP-816) NONAQUEOUS ELECTROPOLISHING BATH FOR URANIUM. Childs, E. L.; Evans, F. E. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Dec. 21, 1966. Contract AT(29-1)-1106. 8p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A nonaqueous bath for electropolishing U that consists of NaH_2PO_2 in 1,2-ethanediol is described. Studies were made of the effects of water content, pH, temperature, and salt concentration on the electropolishing procedure. Surface roughness using this method is reduced to about 60 percent of the original value. (auth)

11201 (RMI-5) QUARTERLY PROGRESS SUMMARY [ON URANIUM FABRICATION], JANUARY-MARCH 1965. (Reactive Metals, Inc., Ashtabula, Ohio). Sept. 14, 1966. Contract AT (30-1)-1405. 53p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A pilot test frame for investigation of the electrical resistance heating method for production length tubing was fabricated. Numerous test runs have been completed to analyze factors such as heating rate versus current density, water cooling capacities to electrical coupling clamps for temperature uniformity control, electrical power circuitry characteristics, etc. The tests performed proved the practicality of this method and provided data for the design and construction of a production unit. The latest analysis of results on the primary extrusion of the NPR-NOE fuel element indicated that the techniques developed are capable of producing NPR-NOE primary extrusions comparable to present quality standards and on a production basis. An experiment which has showed some promising results, was directed towards the "upset-forge" route for fabrication of both NPR-NIE and NOE billets. Billet prelubrication and a 90° die approach angle have been investigated as possible means of reducing the extrusion pressure for the Mark VE-O fuel element. Evaluation for the extrusion of Mark VE-I with a water cooled mandrel has been completed. Evaluation of the water cooled mandrel for extrusion of the Mark VE-O size has been initiated. Results have indicated the probability of increasing mandrel life but only under conditions that promote coarse grained texture in the extrusion. The NPR-NOE piercing project has been extended to include piercing of a 4.7 ID. This project is also being co-ordinated with NPR-NOE project for extrusion using a tipped mandrel. (P.C.H.)

11202 FABRICATION OF TUNGSTEN AND TUNGSTEN-25 PERCENT-RHENIUM TUBING. Isserow, Saul; Jenkins, Robert G.; Hunt, James G.; Friedman, Gerald I. (Textron Inc., West Concord, Mass.). Nucl. Appl., 2: 304-7(Aug. 1966).

Techniques were developed for the fabrication of seamless W and W-25% Re tubing. Appropriate procedures were established for primary extrusion, re-extrusion, and warm drawing. The extrusion uses the filled-billet technique, with Mo serving as the expendable filler which is subsequently removed chemically. Tubing dia studied were from ≈½ in. to <0.1 in., wall thicknesses being ≈0.1 times the dia. A 64 ft-lot of W-25% Re tubing, 0.250-in. OD × 0.020-in. wall, was produced by primary extrusion and a series of moving-mandrel draws. (auth)

11203 FABRICATION OF CLAD U-Pu ALLOY RODS, DESIGNED FOR THE STUDY OF Pu RECYCLING IN THERMAL REACTORS. Bussy, P.; Ganivet, M.; Mercier, C.; Pajot, J.; Stosskopf, F. (Commissariat a l'Energie Atomique, Paris). Energ. Nucl. (Milan), 13: 440-7(Aug. 1966). (In French).

The technique for the fabrication and control used in the reprocessing of approximately 3 tons of Pu alloys with various concentrations were described. These clad alloy rods were used for various critical experiments and oscillation experiments in reactors. The control and the fabrication balances, together with the results obtained as the function of the imposed specifications, are emphasized. (tr-auth)

11204 METHOD OF PREPARING NIOBIUM BASE ALLOY WIRE. Fraser, Malcolm J.; Wien, Raymond E. (to Westing-

house Electric Corp.). U. S. Patent 3,278,344. Oct. 11, 1966. Filed July 29, 1963.

A method is described for the preparation of a Nb–Zr alloy that is suitable for use for the fabrication of long lengths of fine wire as for use in superconductivity applications. Commercial purity Nb and Zr in the form of bars or rods are comminuted to a small particle size, and the particles are pressed to a shape that can be used as a consumable electrode. Alternatively, a suitable electrode can be formed by preparing a sandwich of alternate layers of Nb and Zr. The electrode is arc melted to ingot form of 1 to 6 in. in diameter in a furnace in a vacuum or an inert atmosphere. The ingot is hot extruded into a wire bar to reduce its columnar microstructure to a banded semi-equiaxed microstructure. The extruded alloy is then cold worked to a minimum of at least 40% cold work and then heat treated at an elevated temperature of about 1000 to 1400°C in a non-oxidizing atmosphere to recrystallize it into a readily cold workable product with equiaxed microstructure. The alloy consists of 10 to 65 wt % Zr and the balance Nb. (B.L.M.)

Properties Evaluations

Refer also to abstracts 10547, 11169, 11189–11191, 11256, 11298, 11394, and 12141.

11205 (AECL–2623) THE EFFECTS OF DISSOLVED OXYGEN UPON THE MECHANICAL PROPERTIES OF ZIRCONIUM–2.5 WT. PERCENT NIOBIUM ALLOY. Kench, J. R.; Foley, J. H.; Aldridge, S. A. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Oct. 1966. 34p. Dep. mn. AECL $1.00.

Specimens of Zr–2.5 wt % Nb were prepared with various levels of oxygen content, ranging from 170 to 2000 ppM by weight. The $(\alpha + \beta)/\beta$ transus temperature was determined metallographically. The observed variation with oxygen content was in good agreement with other results available. Hardness values, at room temperature, increased with increasing oxygen content up to ~800 ppM, then less rapidly up to 2000 ppM. Results were indistinguishable for specimens that were β-quenched, $(\alpha + \beta)$-quenched, β-quenched and aged, or $(\alpha + \beta)$-quenched and aged; but a relatively large scatter in all results was noteworthy. The yield and ultimate tensile strengths, the reduction of area and elongations of both β-quenched and $(\alpha + \beta)$-quenched specimens were obtained as a function of oxygen content from tensile tests conducted at room temperature and 300°C. The effect of the oxygen on the properties differed for different test temperatures and for different heat treatments, but in all instances a discontinuity was apparent around 800 ppM. The results are tentatively explained in terms of competition between solution (oxygen) and precipitate (Nb) hardening. (auth)

11206 (AECL–2634) THERMAL DIFFUSION OF HYDROGEN IN FINNED ZIRCALOY-2 PRESSURE TUBES. Wilkins, B. J. S.; Sawatzky, A. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Oct. 1966. 14p. Dep. mn. AECL $0.50.

The mechanical properties of Zr-alloy pressure tubes may be seriously impaired by the absorption of H_2 from the reactor environment. This would lead to an unacceptable restriction of their service life. A new approach to the problem, exploiting the phenomenon of thermal diffusion, is described. It was demonstrated that hydrogen (hydride) may be moved, by a maintained thermal gradient, from a Zircaloy-2 pressure tube into an attached Zircaloy-2 sink. The sink consisted of fins welded along the tube length. (auth)

11207 (AGN–8205) EVALUATION STUDY OF HASTELLOY X AS A NUCLEAR CLADDING. Quarterly Progress Report, July 5–September 30, 1966. (Aerojet-General Nucleonics, San Ramon, Calif.). Contract AT(04-3)-368. 57p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Oxidation and mechanical property studies were carried out on low- and commercial-cobalt Hastelloy X heats. Metallography, x-ray analysis, and tensile testing were carried out for specimens exposed in air and inert gas at different temperatures. Specimens were tensile creep tested at 1800°F in air. The resulting data were compared with bending creep data; the systematic differences are attributed to imposed stress distribution and surface condition. (D.L.C.)

11208 (ANL–7155, pp 167-289) BASIC METALLURGY. (Argonne National Lab., Ill.).

Developments are reported for studies on: metallurgy of actinide metals; uranium and plutonium ceramic compounds; diffusionless phase transformations in hcp metals; diffusion in metals; transition metal alloys; physical ceramics; x-ray and neutron diffraction studies; irradiation effects and defects in metals; and corrosion. (P.C.H.)

11209 (NP–16627) EFFECT OF CARBON ADDITIONS ON THE SHEAR MODULUS OF TUNGSTEN AND A TUNGSTEN–3 PERCENT RHENIUM ALLOY. Hay, D. R.; Scala, E. (Cornell Univ., Ithaca, N. Y.). [1965]. Contract DA-31-124-ARO-D228. 20p.

Chemical interactions of Re and C with the W matrix were studied by observing changes in shear modulus with composition. The addition of 3% Re to W decreased the shear modulus from 19.6×10^6 to 16.1×10^6 psi. Carbon additions did not change the modulus of the pure W, but 70 ppm C increased that of the alloy to 18.7×10^6 psi. The observed alloying behavior was correlated to the electronic structure. The changes in modulus were attributed to changes in the electronic structure of the metal upon alloying. Differences in the behavior of C in the pure W and the alloy were related to an increased C solubility in the alloy, which in turn is a function of the electronic structure of the metal. (auth)

11210 (BDX-613-92) COMPARATIVE DUCTILITY OF BRITTLE METALS BY A PRECISION ELONGATION TECHNIQUE. Patterson, Edward P. (Bendix Corp., Kansas City, Mo.). Dec. 1, 1966. Contract AT(29-1)-613. 17p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A method of measuring elongation was developed, by which the accuracy of measurement can be increased by one or more orders of magnitude. The method utilizes taperless specimens and measurements of diameters at several distances from the fracture face. Its method is particularly useful in the evaluation of brittle metals, where determination of elongation by this method is simplified, and where accuracy of results is most important. (auth)

11211 (CONF-660647–1) EXPERIMENTAL DEVELOPMENTS IN LOW-CYCLE FATIGUE RESEARCH ON PRESSURE VESSEL STEELS AT ELEVATED TEMPERATURES. Slot, T. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). June 1966. Contract AT(40-1)-2847. 26p. (GE-TM–66-6-11). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Symposium on Low Cycle, Thermal Stress Fatigue, Experiment and Design, Schenectady, N. Y.

Progress is reported on development of experimental procedures for uniaxial fatigue testing at elevated temperatures up to 1000°C. Performance of servocontrolled, hydraulic testing machines and associated heating and strain-measuring equipment is discussed. Typical low-cycle fatigue test results are presented for AISI 304 stainless steel in the temperature range from room temperature to 800°C. (auth)

11212 (EURAEC–1712) WELDED CONNECTION MADE FROM THICK HIGH-STRENGTH STEEL; TESTS USING FRACTURE CRITERIA BASED ON NEW CONCEPTS AND THE INFLUENCE OF STRAIN RATE. Quarterly Report No. 3, April–June 1966. (Oerlikon Elektrodenfabrik Eisenberg G.m.b.H. (West Germany)). 126p. (EUR–2894). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Investigations were made of the influence of notch radius of a notched bar test piece on test results. Oscillographic recordings were made of force/space curves for fracture of Coheracy test pieces. Correlations were made between Robertson and Coheracy results, using steels that were already subjected to a Robertson test. Results are presented in tables and graphs. (M.C.G.)

11213 (GAMD–7377) EXPOSURE OF HTGR CANDIDATE CORE PLATE AND THERMAL INSULATION MATERIALS TO IMPURE HELIUM AT 1650 DEG F TO 1850 DEG F FOR 3000 HOURS. Wunderlich, J. W.; Baker, N. E. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Dec. 29, 1966. Contract AT(04-3)-633. 33p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The following materials were exposed in He containing 3000 ppm CO and H_2 at 1650 and 1850°F: Rene 41, Inconel X, Hastelloy X, 304 stainless steel, 430 stainless steel, and Incoloy 800. Changes in mechanical properties and microstructures were evaluated after 500 and 1500 hr exposure of the above materials, and after 3000 hr for 430 stainless steel and Hastelloy X. The results show that 430 stainless steel is the best choice as metallic thermal insulation material in an HTGR, although Hastelloy X is least affected by the environment. (D.L.C.)

11214 (INR–752/XIV/PS) DYFUZJA WZAJEMNA URANU I CYNKU. (Interdiffusion in the Zn–U System). Gabrytski, S. (Institute of Nuclear Research, Warsaw (Poland)). Sept. 1966. 14p. (In Russian). Dep.

Diffusion-layer growth in the interdiffusion in the Zn–U system was investigated at 205 to 400°C. The activation energy and the coefficient K_0 were determined. (auth)

11215 (LA–3623) SOLUBILITIES OF SELECTED ELEMENTS IN LIQUID PLUTONIUM. X. THULIUM. Bowersox, D. F.; Leary, J. A. (Los Alamos Scientific Lab., N. Mex.).

Nov. 4, 1966. Contract W-7405-eng-36. 10p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The reversibility of the Tm–Pu system was established at low Tm concentrations, and the solubility values for Tm in liquid Pu were determined from 700 to 1000°C. The solubility, which was measured in both CaF_2 and Ta crucibles, increased from 1.67% Tm (by weight) at 700°C to 6.15% Tm at 1000°C. The equation $\log N_{Tm} = 0.736 - 2.28 \times 10^3 T^{-1}$, where N_{Tm} is the solubility expressed as the mole fraction and T is the temperature in °K, fits the data in the temperature range studied. (auth)

11216 (MND-3607-114) SNAP 19 TEST REPORT: FEASIBILITY TESTS, HIGH ENTHALPY DISINTEGRATION OF MAGNESIUM. Woolf, W.; Grim, G. (Martin Co., Baltimore, Md.). Oct. 1966. Contract AT(30-1)-3607. 58p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An experimental evaluation was made of various techniques for an extensive high enthalpy test program for Mg alloys. Twenty-four Mg alloy test specimens (eight HM31A alloy, SNAP 19 casing material and 16 ZH62A alloy, sensory ring structural material) and seven stainless steel heat meters were fabricated. The evaluation program was conducted in two arc-jet wind tunnels. Test results indicated that thermocouples can be used to define the regression rate of a metal surface as well as the temperature history of the material. The use of simplified regression sensors to provide surface regression rates did not prove feasible because of spurious or no signal generation throughout the test runs. The use of motion pictures to record surface regression rates appeared to be the most promising method of achieving good results. However, this method would be enhances if it were coupled with stroboscopic photographic techniques to more clearly define the receding surface. The failure of the movies to record the existence of combustion phenomena in no way indicates the nonexistence of such phenomena in the reentry of Nimbus B since the energy levels experienced during the tests were lower than expected. Spectrographic records taken at fixed periods are not capable of sensing the onset of the emission of MgO of wavelength 5078 Å or Mg atoms of wavelength 5183 Å which accompany the start of melt. In addition, spectrography as used in the test program cannot discriminate between MgO formation resulting from slow oxidation or from combustion. If the spectrograph was coupled to a photomultiplier and recorder, a continuous record of the occurrence and intensity of an emission of given wavelength would be available. An attempt was made to determine the fundamental mode of disintegration of Mg alloys; however, neither the vehicle geometry tested nor the data obtained were sufficient for use in establishing the failure mode. (D.L.C.)

11217 (N-66-19519) THERMAL PROPERTIES OF SOLID AND POROUS TUNGSTEN AT TEMPERATURES TO 5000 DEG F. Israel, S. L.; Hawkins, T. D.; Hyman, S. C. (United Nuclear Corp., White Plains, N. Y. Development Div.). Mar. 1966. Contract NAS3-3205. 50p. (NASA-CR-402). CFSTI $3.00 cy, $0.65 mn.

An experiment was conducted to determine the thermal conductivity of solid and porous tungsten at temperatures up to 5000°F. The method used was to measure the temperature distribution on the top surface of a cylindrical specimen heated in a vacuum by r-f induction currents and radiating freely. The thermal conductivity was determined by equating the axial heat flux within the specimen to the radiation flux at the center of the top surface. A digital computer program was used to relate the axial heat flux within the specimen to the temperature distribution on the top surface. The results of this computer study were used to determine a proportionality factor that permits calculating the axial temperature gradient and heat flux at the center of the top surface from the measured top surface temperature distribution. The thermal conductivity of solid tungsten was found to vary from 76 Btu/hr-ft-°F at 3000°F to 66 Btu/hr-ft-°F at 5000°F. The thermal conductivities calculated for porous tungsten specimens are 10 to 15% of the solid thermal conductivity. Thermal conductivity data for the porous specimens vary little with temperature, indicating that internal radiation had no significant effect on the effective thermal conductivity. (auth)

11218 (NP-16465) GENERATION OF LONG TIME CREEP DATA ON REFRACTORY ALLOYS AT ELEVATED TEMPERATURES. Quarterly Report No. 13, July 26, 1966–September 26, 1966. Sawyer, J. C.; Steigerwald, E. A. (TRW Equipment Labs., Thompson Ramo Wooldridge Inc., Cleveland, Ohio). Oct. 14, 1966. Contract NAS 3-2545. 111p.

Creep data are presented for vapor-deposited W at 2800 and 3200°F, TZC and TZM at 1600 to 2250°F, and T-111 at 1800 to 2600°F. The alloys are in the form of rolled sheet and forged plate with the former being considered as representative of material for cladding tubing applications and the latter for turbine components. Vapor-deposited W was evaluated as ⅛ in. dia bar machined from the wall of vapor-deposited tubing. (P.C.H.)

11219 (SRIA-425-9) SORPTION OF GASES ON METAL SURFACES IN ULTRAHIGH VACUUM. Final Report, February 15, 1966 to August 14, 1966. Bergsnov-Hansen, B.; Endow, N.; Evans, B.; Pasternak, R. A. (Stanford Research Inst., Menlo Park, Calif.). Sept. 1966. Contract AT(04-3)-425. 90p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The chemisorption of O_2 on Mo films was investigated and the sticking probability curve at 300°K is shown. The initially high sticking probability decreased continuously with coverage. When the same film was cooled to 77°K, an additional amount of only 0.7×10^{14} molecules cm^{-2} was adsorbed. The sticking probability at 77°K was virtually independent of coverage. Studies on H_2-D_2 exchange on Mo surfaces and O_2 adsorption on Nb are also reported. (M.C.G.)

11220 (TRG-Report-1345) ADDITION OF YTTRIUM TO STAINLESS STEELS. Parsons, P. D. (United Kingdom Atomic Energy Authority, Springfields (England). Reactor Group). 1967. 8p. Dep. mn.

The influence of Y on the physical metallurgy of various Fe–Cr and Fe–Ni–Cr alloys is reviewed. The availability and the physical properties of Y are also discussed. The addition of ~1% Y to 20–25-Nb stainless steel results in a marked improvement in grain stability below ~1200°C, due to particles of an Y intermetallic phase. Above ~1200°C grain growth is significant and the intermetallic phase is redistributed around the grain boundaries. Prolonged heating at high temperatures in air results in oxidation of the Y phase and an apparent embrittlement of the alloy. The main contents of this Report were originally published in the New Scientist, 32: 19(1966). (auth)

11221 (WAPD-TM-585) PROPERTIES OF ZIRCALOY-4 TUBING. Woods, C. R. (ed.) (Bettis Atomic Power Lab., Pittsburgh, Pa.). Dec. 1966. Contract AT(11-1)-Gen-14. 235p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

In order to obtain design information of Zircaloy-4 tubing, an extensive test program was carried out which included as materials variables the fabrication method, grain size, and cold-work, and as test variables temperature and time. The tests included conventional longitudinal tensile tests as well as internal and external pressure tests to more nearly simulate service loading conditions, biaxial tests to determine the degree of anisotropy present, and ring tests to obtain transverse properties. Physical properties investigated included corrosion rates (and concomitant hydrogen pickup), crystallographic texture, hydride distribution, and annealing kinetics. Results include the following: a determination of the effect of texture on hydride orientation and on the variation of yield strength with loading condition, proof that the improvement in properties conferred by cold-work is not retained under low stress creep conditions, and proof that cold-work hardening and irradiation hardening are not additive in all cases. (auth)

11222 (AERE-Trans-1060) SYSTEMATICS OF LIQUID METALS AND ALLOYS. VII. THE PRESENT POSITION OF SYSTEMATIC TREATMENT OF LIQUID ALLOYS. Sauerwald, F.; Brand, P.; Menz, W. Translated by O. S. Whitston (Atomic Energy Research Establishment, Harwell, Eng.), from Z. Metallk., 57: 103-8(1966). 15p. Dep. mn. BIS $0.50. HMSO 2s. 6d.

As part of a systematic scheme of the properties of molten binary alloys, the results of new investigations are added and checked to what extent the classification into compound, solution, segregation, and intermediate systems is justified. Of the 789 constitutional diagrams examined with their groups of properties, only 23 did not fit satisfactorily into the present scheme. The conclusions derived from the scheme are discussed. A bibliography of 80 references is included. (auth)

11223 SYSTEM V_3Si-V_3Ga. Savitskii, E. M.; Baron, V. V.; Efimov, Yu. V. (Inst. of Metallurgy, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 1444-7(Aug. 1966). (In Russian).

The V_3Si-V_3Ga system was studied by x-ray microstructure and microhardness techniques. The object of the work was to establish the point of transition of the system into a superconductive material and to determine the structures of the alloys of the V_3Si-V_3Ga system. The samples were prepared by fusing mixtures of pure components in an arc furnace in argon atmosphere at 0.9 atm. All samples were homogenized by holding them for 2500 hours at 800°C. The continuous formation of the solid solutions between isomorphic compounds, V_3Si and V_3Ga, at 800°C was established by both x ray and microhardness examinations. The maximum microhardness of 1680 kg/mm^2 was found to correspond to 5 to 7.5 atom % Ga in the solid solution. At all intercomponent ratios, the solid solutions of V_3Si and V_3Ga were found to have a lattice structure of the Cr_3Si-type. Above 1300°C, the V_3Si-V_3Ga system was found to be composed of two distinct

phases: a solid solution based on vanadium and the V_3Si. The transition temperature of the various compounds of V_3Si-V_3Ga system into the superconducting state can be calculated from the empirical formula $T_K = 17.1 \cdot e^{-0.074x} + 0.059 \cdot e^{0.216x}$, where x- is the Ga content in the system in atom %. (ATD)

11224 CHEMICAL VAPOR DEPOSITION OF Mo ONTO Si. Casey, J. J.; Verderber, R. R.; Garnache, R. R. (Sprague Electric Co., North Adams, Mass.). J. Electrochem. Soc., 114: 201-4(Feb. 1967).

Mo was deposited on single crystal silicon substrates by the vapor phase decomposition of Mo chlorides. The thickness, alloy phase, and crystalline nature of the films were studied as functions of substrate temperature, substrate orientation, and source material, using electron microscopy and reflection electron diffraction. (auth)

11225 ELASTIC PROPERTIES OF THE ALLOYS OF NIOBIUM WITH TANTALUM, VANADIUM, AND TITANIUM. Nedyukha, I. M.; Chernyi, V. G. (Inst. of Metal Casting Problems, Academy of Sciences, Ukrainian SSR). Fiz. Metal. Metalloved., 22: 114-17(July 1966). (In Russian).

The study of these properties for alloys of the Nb–Ta, Nb–V, and Nb–Ti systems is of interest considering that their components either display nearly identical values of the modulus of normal elasticity (Nb–V, Nb–Ti) or greatly differ in these values (Nb–Ta). Accordingly, alloys containing 5 to 80 wt % Ta, 2.5 to 80 wt % V, and 5 to 41 wt % Ti were melted in an argon-atmosphere arc furnace and the resulting cast specimens were investigated. Elastic properties (modulus of elasticity E, modulus of shear G, volumetric modulus of elasticity Q, and Poisson ratio μ) were measured by ultrasonic and other methods described in a previous investigation. It was found that an increase in the proportion of Ta in Nb–Ta alloys leads to a marked increase in E, G, and Q and to a decrease in μ. The effect of V on Nb is more complex: in Nb–V alloys containing up to 40% V, the moduli E and G increase markedly while μ sharply decreases. In the alloy with 40% V, E = 14,730 kg/mm², G = 5,440 kg/mm², μ = 0.355. As the V content increases further, however, E and G decreases. The effect of Ti on Nb also is distinctive: Nb–Ti alloys containing 5% Ti display some increase in E and G, but any further increase in their Ti content leads to a steady decrease in E and G. An analysis of these findings reveals interesting regularities: in every case a change in one of these characteristics leads to an opposite change in another characteristic. This is associated with the mean square deviations $\sqrt{\overline{u}^2}$ of atoms from the equilibrium position. Thus, in every case, the curves of E and $\sqrt{\overline{u}^2}$ are mirror images of each other, as it were. As a byproduct of this investigation, it is established that the characteristic temperature does not always reflect the actual nature of changes in the strength of interatomic bonding on alloying. (ATD)

11226 DIFFUSION OF MOLYBDENUM IN IRON AND AN IRON–MOLYBDENUM ALLOY. Borisov, V. T.; Golikov, V. M.; Shcherbedinskii, G. V. Fiz. Metal. Metalloved., 22: 159-60 (July 1966). (In Russian).

It is of interest to investigate the diffusion of a surface-active component in an alloy already containing the same component. Theory indicates that for surface-active substances, under the conditions of a thermodynamic equilibrium, the coefficients of volume diffusion and diffusion along grain boundaries should not markedly differ from each other. If, on the other hand, the component diffuses through a pure solvent, it chiefly penetrates along the grain boundaries. Therefore, if the concentration of the active element is increased (to its equilibrium value), its mobility along the grain boundaries must decrease. Mo is a surface-active element with respect to Fe. The diffusion of Mo (^{99}Mo electrolytically deposited on the surface) in polycrystalline specimens (with nearly uniform grain size: 5 to 10 μ) of pure Fe and Fe–Mo (0.7% Mo) alloy. The mean diffusion coefficient D_{av}, averaged for both volume diffusion and diffusion along grain boundaries, was determined by laminar analysis, while the coefficients for volume diffusion D_{vol} and diffusion along grain boundaries were separately determined by the absorption-kinetic method. For diffusion of Mo in pure Fe: $D_{av} = 0.3 \exp(-49{,}000/RT)$, and $D_{vol} = 7.8 \times 10^3 \exp(-73{,}000/RT)$. For diffusion of Mo in Fe–Mo alloy: $D_{av} = 2.24 \times 10^2 \exp(-64{,}000/RT)$ and $D_{vol} = 1.3 \times 10^4 \exp(-75{,}000/RT)$. The temperature dependence of D_{av} and D_{vol} indicates that the values of D_{av}, determined by laminar analysis, are higher, and the activation energy is lower, compared with the corresponding characteristics for purely volume diffusion. This is associated with the effect of grain boundaries, which is much smaller in the case of the Fe–Mo alloy. And indeed, the findings obtained by the absorption method indicate that, while activation energy and D_{vol} are similar in both pure Fe and in Fe–Mo alloy, the mobility of Mo atoms along grain boundaries is higher in pure Fe than in the Fe–Mo alloy. These findings confirm the above reasoning on the effect of surface-active elements. (ATD)

11227 EFFECT OF OXIDES ON THE PROPERTIES OF MOLYBDENUM. Mironov, O. S.; Shmakov, A. D.; Batenina, O. I.; Novikova, K. Z.; Danielyan, T. A.; Tyukalov, Yu. M. Fiz. Metal. Metalloved., 22: 138-40(July 1966). (In Russian).

Oxygen is a harmful impurity in Mo, inducing its embrittlement at low temperatures. Northcott (1959) claims that oxygen is present in Mo in the form of the oxide MoO_2, but it would be more correct to assume that the composition of the oxides is not unambiguous and should be expressed by the formula Mo, O_y. To investigate the behavior of Mo oxides during heating and cooling, an oxide close in composition to that of MoO_2 was obtained following partial reduction of the polymorphic oxide MoO_3. The obtained powder was pressed into 10 × 10 mm briquets and sintered in an argon atmosphere at 1000°C for 6 hr. The oxide's coefficient β of linear expansion at high temperature (up to 800°K) was measured with the aid of dilatometers, and its phase composition before and after sintering examined by x-ray structural analysis; the roentgenograms indicated that the composition of the investigated oxide corresponds to that of Mo_2O_3. An analysis of the temperature dependence of β (coefficient of linear expansion) showed that at from 150 to 20°C the value of β for Mo_2O_3 sharply decreased. Any further decrease in temperature, however, leads to a sharp rise in β. Considering that a similar anomaly is observed for MoO_3, it may be assumed that this effect is characteristic of Mo oxides in general. These findings also serve to elucidate the effect of oxygen on the properties of Mo with decrease in temperature. The mean β for Mo varies from 5.1×10^{-6} at 0°C to 5.59×10^{-6} at 500°C (Teplofizicheskiye svoystva veshchestv, spravochnik pod red. N. B. Vargaftika, M., Gosenergoizdat, 1956); the β for the oxide is somewhat lower. Moreover, at <100°C the β for the oxide sharply decreases. Thus, the volume of inclusions of molybdenum oxides decreases at a slower rate than the volume of the surrounding metal. If an oxide particle is present within a grain, the latter is subjected to internal compressive stresses which lead to an increase in hardness and decrease in plasticity. A more harmful effect is exerted by the oxide particles when they occur in between the grains. In this case tensile stresses leading to brittle intercrystalline fracture arise at the surfaces of contact between grains. Moreover, it is known that oxides in Mo are located chiefly along the grain boundaries. This probably is the reason why semifinished Mo products, with their high content of oxygen in recrystallized state, display a distinct tendency toward brittle intercrystalline fracture. (ATD)

11228 DIFFUSION OF BERYLLIUM IN MAGNESIUM. Erko, V. F.; Zelenskii, V. F.; Krasnorutskii, V. S. (Inst. of Physics and Tech., Kharkov). Fiz. Metal. Metalloved., 22: 112-14(July 1966). (In Russian).

A Mg–Be alloy containing 0.2% Be was produced by simultaneous deep-vacuum evaporation and condensation of Mg and Be on a single substrate. Metallographically, the compound was represented by a solid solution of Be in Mg which included tiny particles of the intermetallic compound $MgBe_{13}$. The resulting alloy was sintered under a pressure of 600 atm at a temperature equal to the temperature of subsequent diffusion annealing. To investigate the effect of hydrostatic pressure on the diffusion of Be in Mg, two lots of specimens were prepared. The first lot was diffusion-annealed at atmospheric pressure in a special steel shell filled with MgO and the second lot was annealed at 600 atm. The distribution of Be in Mg was determined by means of local spectral analysis. The resulting findings on the solubility of Be in Mg as a function of temperature were used to derive the formula for the diffusion coefficient D of Be in Mg: $D = 8.06 \exp(-37{,}490 \pm 2700/RT)$. Increasing the pressure to 600 atm during diffusion annealing does not affect the diffusion rate. (ATD)

11229 ADSORPTION OF SILICON ON TUNGSTEN. Neumann, Hans (Karl-Marx Univ., Leipzig). Ann. Phys. (7), 18: 144-58 (1966). (In German).

The adsorption of Si on W was investigated using the Mueller field electron microscope. The emission properties and the desorption of Si from a W surface are described. The emission properties can be explained if a characteristic band structure is assigned to very thin Si layers on W. The measured desorption energies indicate a formation of metallic character between Si and W. (tr-auth)

11230 STRESS IN THE OXIDE FILMS ZIRCONIUM AND ZIRCALOY-2 DURING ANODIC OXIDATION. Nomura, Sueo (Japan Atomic Energy Research Inst., Tokyo); Saruyama, Ichiro. Denki Kagaku, 33: 723-7(Oct, 1965). (In Japanese).

The stress in the oxide films of pure Zr and Zircaloy-2 (Zy-2), formed by anodic oxidation at room temperature, was studied. If the deformation occurred within its elastic limit, the calculated stress was found to be as large as 50 kg/mm². Consequently, cracks may be produced in the oxide film, which was confirmed by the electron-microscopic observation. The stress tended to approach a definite value when the depth of oxide films was above

2000 to 3000 Å, and the cracking phenomenon became larger beyond this point. The stress was measured also for pure Zr and Zircaloy-2 in which 2000 ppM O_2 was dissolved as a solid solution; pure Zr showed less stress than Zircaloy-2 and the original Zircaloy-2 showed less stress than that treated with oxygen. The bending phenomenon at elevated temperatures was observed, and the stress between the oxide films at elevated temperatures was estimated. (NSA of Japan)

11231 TEMPERATURE AND STRAIN-RATE DEPENDENCE OF THE FLOW STRESS IN MOLYBDENUM. Guiu, F. (Imperial Coll. of Science and Tech., London). Phys. Status Solidi, 19: 339-51(Jan. 1, 1967).

The effect of orientation on the temperature and strain-rate dependence of the flow stress of molybdenum single crystals is investigated over the temperature range from 195 to 413°K. The values of the activation parameters ΔH, w, and ν are calculated assuming that a single mechanism is rate controlling. It is found that the activation volume at constant stress is a function of the temperature. This together with other results suggest that the deformation is controlled by more than one thermally activated mechanism. An explanation is proposed based on both the overcoming of the Peierls barrier and the nonconservative movement of jogs in screw dislocations. The results also indicated that in the range of temperatures from 300 to 350°K there is a change in the rate-controlling deformation process. (auth)

11232 DEVELOPMENT OF HIGH-STRENGTH CORROSION-RESISTANT ALLOY. Gulyaev, A. P.; Zotova, E. V.; Ustimenko, M. Yu.; Posysaeva, L. I. Izv. Akad. Nauk SSSR, Metal., No. 5, 102-6(Sept.-Oct. 1966). (In Russian).

0Kh23N28M3D3T (EI943) steel has adequate corrosion resistance in H_2SO_4 at temperatures up to 80°C but its low strength limits its use in the modern chemical industry. Therefore, efforts have been made to develop an alloy which will combine the necessary corrosion resistance with adequate strength. A series of Fe–Cr–Ni base alloys additionally alloyed with Ti, Nb, Al, Mo, and Cu were tested. On the basis of experimental findings, the new 0KhN40MDTYu alloy (Electrostal Plant designation EP543) was developed. The alloy contains 0.06% C, 0.8% Si, 0.8% Mn, 14 to 17% Cr, 39 to 42% Ni, 4.5 to 6% Mo, 2.5 to 3.2% Ti, 0.7 to 12% Al, and 2.7 to 3.3% Cu. The alloy is age-hardenable. The alloy solution-heat treated and aged at 700 to 800°C has the following minimum values of mechanical properties: tensile strength 100 kg/mm², yield strength 70 kg/mm² and elongation 10%, compared to 50 to 55 kg/mm², 20 to 25 kg/mm², and 30 to 35% for EI943 steel. The corrosion rate of the new alloy in H_2SO_4 at concentrations up to 40% and temperatures up to 50°C is approximately 0.1 g/m²/hr. (ATD)

11233 LATTICE DYNAMICS, ELECTRONIC STRUCTURE, AND ELECTRICAL PROPERTIES OF SIMPLE METALS. II. RUBIDIUM, CESIUM, AND LEAD. Schneider, T.; Stoll, E. (Eidgenoessische Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). Phys. Kondens. Mater., 5: 364-70(1966).

The Fourier transform of the effective electron-ion-potential of Pb was determined from the measured phonon dispersion curves. For Rb and Cs, the elastic constants and the fact that only the Coulomb interaction between the ions contributes significantly to the phonon frequencies of the lowest transverse [110]-branch were used. Using this model potential, the distortions of the Fermi surface and the electrical resistivity were calculated. (auth)

11234 IMPROVING THE QUALITY OF MARTENSITIC STEEL BY TREATING IT WITH RARE EARTH METAL ALLOYS. Kravchenko, V. F.; Isakov, I. V.; Khlebnikov, A. E.; Dashevskii, Yu. A.; Lebedev, Ya. I.; Selivanov, N. M. Izv. Akad. Nauk SSSR, Metal., No. 3, 3-18(May-June 1966). (In Russian).

The effects of REM on specific properties of steel are investigated, procedures for alloying steel are noted, and optimum REM content to achieve desired combinations of mechanical properties is indicated. Chemical thermodynamic data and composition of REM alloys are presented in order to provide a better understanding of the principles involved in alloying steel with REM. Experimental melts were produced in a 150-ton induction furnace as well as in 25 and 200 ton basic open hearth furnaces. Misch metal, a rare earth alloy containing 56.1% Ce and 41.3% La (other REM, Fe, and impurities totaled 2.6%), was used as the deoxidizing agent. Studies were made of both cast and wrought metal states and tables of mechanical properties are included. The impact strength of steel 40Kh2NMa, melted in a 25-ton furnace and top-poured at 1580°C, is given. Results of the experiments showed that in all cases the addition of REM increased steel ductility. This increase was greatest when the misch metal was able to reduce S content in the solidified ingot. Desulfurization was best accomplished when it was initiated in the ladle prior to pouring into the mold. Optimum conditions were concluded to be ladle deoxidation and desulfurization by adding 0.15 to 0.20% misch metal (calculated) to the molten steel (1560–1580°C) immediately after tapping from the furnace. The misch metal reaction begins and most of the S is removed by the time the steel is poured and solidified. The procedure lowers the S content 25 to 30%. The misch metal significantly reduces nonmetallic inclusion content, as well as changing the shape, composition, and distribution of that content. Finally, the REM alloy increases impact strength of the rolled steel 27 to 47% (transverse test samples) and of cast steel by 47 to 65%, with a simultaneous increase in ductility. (ATD)

11235 EFFECT OF ALLOYING ELEMENTS ON RECRYSTALLIZATION OF MAGNESIUM-BASE ALLOYS. Drits, M. E.; Felgina, S. B. Izv. Akad. Nauk SSSR, Metal., No. 4, 75-83(July-Aug. 1966). (In Russian).

The effect of additional alloying with Ce, Al, Mn, Ni, or Zn on the recrystallization temperature of Mg–Mn, Mg–Nd, and Mg–Al alloys has been investigated. Mg–1.5% Mn alloy was additionally alloyed with 0.2 to 3.0% Ce or 0.1 to 2.0% Al; Mg–3.0% Nd alloy, with 0.2 to 1.5% Mn or 0.1 to 1.0% Ni; and Mg–4.5% Al alloy, with 0.2 to 1.5% Zn or Mn. Alloy specimens annealed to a coarse-grain structure were upset at room temperature with 60% reduction, annealed at 100 to 450°C for 1 hr, and air cooled. Obtained data showed that in Mg–Mn alloy, 0.43% Ce raised the temperature of the beginning of recrystallization (t_{br}) from 150 to 300°C, while 0.15 to 1.0% Al raised it only to 175°C; at higher content of either element, the t_{br} dropped. Alloying of Mg–Nd alloy with 0.5% Mn raised the t_{br} from 325 to 375°C, but at 1.5% Mn, the t_{br} dropped to 350°C; 0.2% Ni had no effect, but 1.0% Ni lowered the t_{br} to 300°C. Alloying of Mg–Al alloy with 0.5% Mn or 1.5% Zn had no effect; 1.5% Mn or 0.5% Zn lowered the t_{br} from 175 to 150°C. Mg–Nd–Mn and Mg–Nd–Ni alloys have the highest temperature of the beginning of recrystallization (300 to 375°C) and the highest ratio of recrystallization temperature to melting temperature. Heat-resistant MA11 alloys, which can operate at temperatures of 250 to 300°C, belong to this group. MA8 and BM17 alloys of the Mg–Mn–Ce system are less heat resistant and are capable of operating at 200 to 250°C. Alloys of the Mg–Al–Mn and Mg–Al–Zn systems have low heat resistance and can be used for operation at 150 to 200°C. (ATD)

11236 MECHANISM OF THE PLASTIC DEFORMATION OF DIFFERENTLY ORIENTED MOLYBDENUM SINGLE CRYSTALS UNDER TENSION. Ageev, N. V.; Babareko, A. A.; Chuprikov, G. E.; Bokareva, N. N. Izv. Akad. Nauk SSSR, Metal., No. 4, 84-9(July-Aug. 1966). (In Russian).

A series of variously oriented Mo single crystals, 4 mm in diameter and 80 to 100 mm long, were stretched at a rate of about 1 mm/min. A strong dependence of mechanical properties on the orientation of crystals was observed. Crystals with the axis oriented in the region bounded by [012], [011], [111], and [112] exhibited a high ductility and deformed with multiple necking with a total elongation of 1.5 to 7%. Crystals with the axis oriented in the region bounded by [012], [112], and [001] had a low ductility and failed in a brittle manner by a cleavage along the plane of the cube with 1 to 2% elongation. In the group of ductile crystals, those with the axis oriented close to [011] deformed locally with a reduction of area of over 90% at a total elongation of about 2%. Crystals with the axis oriented close to [111] deformed uniformly with necking beginning at a total elongation of about 7%. In all cases, deformation proceeded by a multiple slip. It is concluded that no dislocation blocking occurs during the plastic yield of crystals with the axis oriented close to [011]; blocking occurs when the crystal axis is oriented close to [111], but it may be overcome by growing stresses. In crystals with the axis close to [001], the blocking of dislocations prevents yielding altogether and finally leads to brittle fracture. (ATD)

11237 ALLOY. Delgrosso, Eugene J.; Kaminsky, John J. (to United Aircraft Corp.). U. S. Patent 3,282,690. Nov. 1, 1966. Filed Dec. 2, 1963.

A method is described for preparing Nb-base alloys that have high tensile strength, good creep resistance, corrosion resistance, and fabricability up to temperatures of about 2400°F. The alloys consist of 1 to 8 wt % Zr, 0.05 to 1 wt % C, 0 to 150 ppM O_2, 0 to 200 ppM N_2, and the balance Nb. The method of making the C addition to the alloys consists of mixing high-purity NbC and ZrC in a weight ratio of Nb to Zr equal to that desired in the alloy, adding excess C to the mixture in the form of a second carbide that is either NbC or Nb_2C with the amount of C present in the second carbide being equal to that lost in the melting process, and melting the mixture in a non-contaminating atmosphere. (B.L.M.)

Structure and Phase Studies

Refer also to abstract 11190.

11238 (RFP-862) SIMPLIFIED METALLOGRAPHIC TECHNIQUES FOR URANIUM ALLOYS AND OTHER METALS. Jackson, Ross J.; Johns, W. L.; Calabra, Arthur E. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Jan. 20, 1967. Contract AT(29-1)-1106. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A simplified metallographic preparation method was developed and proved suitable for many U alloys, as well as for Be and stainless steel. Samples used in the study were taken from a cut-off wheel or 600-grit paper and placed in an electrolytic cell. Through the procedures developed, mounting and polishing steps were eliminated and economies in operations achieved. (auth)

11239 (AERE-Trans-1059) STRUCTURE OF AMORPHOUS GERMANIUM AND SILICON. Richter, H.; Breitling, G. Translated by J. B. Sykes (Atomic Energy Research Establishment, Harwell, Eng.), from Z. Naturforsch., 13a: 988-96(1958). 16p. Dep. mn. BIS $0.60. HMSO 3s. 0d.

Amorphous vapor-deposited films of Ge and Si have been examined by means of Cu Kα, MoKα, and filtered Ag radiation. The interfering K radiation from Ge was eliminated by means of a silver or Pd foil of thickness 100 to 150 μ. Fourier analysis of the intensity curves gave practically identical atomic distribution curves for all types of radiation. It follows that amorphous Ge and Si have a layer group structure of (111) planes with thickness about 15 Å. The layers are heavily perturbed, even individually. Layer formation appears to be a general and important feature of the amorphous non-crystalline state. Because of the requirement of continuous space-filling, the groups are joined by transition regions in which the atoms have a largely disordered distribution. When the amorphous vapor-deposited films of Ge were annealed, the ordering at first became less, but increased again above 300°C. Unlike As, Sb, Se etc., no formation of crystals in small regions was observed when amorphous Ge was annealed; instead, the transition from amorphous to crystalline occurred suddenly, without previous formation of small crystallites. From the observed numbers of atoms and distances of first coordination it was concluded that σ_{am}, the density, is about 10% less than σ_{cr} for Ge and Si. (auth)

11240 SYSTEM Mo-Fe-Si. Skolozdra, R. V.; Gladyshevskii, E. I. (Lvov State Univ.). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 1448-53(Aug. 1966). (In Russian).

The phase diagram of the tertiary system, Mo-Fe-Si, was studied at 800°C. For various samples, the lattice parameters were determined by the x-ray technique. The study involved 133 individual samples prepared by fusing mixtures of Mo, Fe, and Si in an electric arc furnace. The existence of the $MoFe_2Si_2$ was confirmed and its crystal structure was found to belong to the rhombic system. The existence of two other compounds Mo_3FeSi and Mo_5Fe_3Si, and of the $(Mo_{0.17}Fe_{0.83})_5Si_3$ phase was also established. The previously reported compound Mo-Fe-Si was found to be a binary solid solution based on $MoFe_2$ stabilized by Si. The solubility of Si in the Mo-Fe μ phase was found to be about 13.5 atom % and the solubility of Mo and Fe in the binary silicides was found to be very low. The stabilizing effect of the silicon on various λ and μ phases was found to be associated with the increased electron concentration when Si is being dissolved in such binary compounds as $MoFe_2$ or $MoFe_{1.3}(Mo_2Fe_3)$. (ATD)

11241 ORDERING OF Y-Gd ALLOY. Katsnelson, A. A.; Deripasko, V. T. (Moscow State Univ.). Fiz. Metal. Metalloved., 22: 151-4(July 1966). (In Russian).

Ordering in the Y-Gd system was studied using specimens containing 27.3 and 62.9 at. % Gd. Powder diagrams were obtained for specimens annealed from 7 to 100 hr at 600 to 1000°C. The structure of both alloys was considered to be a superlattice on the basis of a hexagonal packing. Tabulated data are given for the superlattice lines and for several basic lines. Increasing the annealing temperature from 600 to 1000°C resulted in diffused and faded superlattice lines in the x-ray picture. However, the front lines (1010) and (0001) for the A_3B_5 type of alloy were retained after tempering and annealing at 1000°C. It was also found that the alloys studied have a long-range and a short-range order, with the long-range order disappearing at 1000°C. (R.V.J.)

11242 CHARACTERISTIC FEATURES OF THE PHASE COMPOSITION OF HEAT-RESISTANT STEELS AND ALLOYS OF THE Fe-Ni-Cr-Ti Mo-W-B SYSTEM. Lashko, N. F.; Sorokina, K. P. Fiz. Metal. Metalloved., 22: 66-72(July 1966). (In Russian).

The phase composition of heat-resistant EI696, EI696M, and EI787 steels has been investigated. Electrolytically isolated precipitates were found to consist of TiC carbide, TiB_2, and Me_3B_2 borides, Fe_2Ti and $Fe_2(Ti,Mo)$ compounds, and $\beta-Ni_3Ti$ phase in amounts depending on steel type and temperature and duration of aging. The $\beta-Ni_3Ti$ phase precipitates in a cubic shape at temperatures above 750 to 800°C. However, lamellar particles of this phase precipitated at grain boundaries in EI696M steel after aging at 750°C for 2000 hr or in EI787 steel after aging for 6000 hr. With prolonged aging, $\beta-Ni_3Ti$ phase of EI696M steel becomes richer in iron. Precipitation of the Fe_2Ti phase in EI696 steel occurs at a lower temperature, about 800°C, and in larger quantities than in EI696M steel. Precipitation of the Fe_2Ti phase in the latter steel occurs only after aging at 900°C for 100 hr or at 750°C for 2000 hr. The phase composition of EI787 steel generally is similar to that of EI696M steel, except that in the former, $Ni_3(Ti,Al)$ replaces $\beta-Ni_3Ti$ and $Ni_3(Ti,Al)$ phase to transform from globular to lamellar form at high temperatures or after prolonged aging is typical for many Ni-Fe-Cr-Al system alloys. (ATD)

11243 THE EXISTENCE OF A CHROMIUM-MOLYBDENUM A15 STRUCTURE. den Broeder, F. J. A.; Burgers, W. G. (Technological Univ., Delft, Netherlands). Acta Crystallogr., 21: 1003-4(Dec. 10, 1966).

During an investigation on Cr-Mo alloys, the x-ray pattern showed, in addition to the bcc reflections of the solid solution, strong extra lines, which could be indexed on a cubic cell with lattice constant $a_\beta = 4.65$ Å. The ratio between the lattice constants of both phases ($a_\beta/a_\alpha = 1.58$) is, within the accuracy attained, practically the same as the ratio between β-W ($a = 5.036$ Å) and bcc W ($a_\alpha = 3.158$ Å), which is $a_\beta/a_\alpha = 1.59$. From intensity calculations of the x-ray pattern, it was concluded that this structure is ordered with 6 Cr atoms situated on the 6(c) sites and 2 O atoms on the 2(a) sites of the A15 cell. Therefore it is suggested that the phase found is a Cr, Mo oxide with the formula $(Cr, Mo)_3O$, having an A15 crystal structure. (P.C.H.)

11244 X-RAY FLUORESCENCE TECHNIQUE FOR THE STUDY OF SEGREGATION IN STEEL. Johnson, M. P.; Beeley, P. R.; Nutting, J. (Leeds Univ., Eng.). J. Iron Steel Inst. (London), 205: 32-5(Jan. 1967).

A technique is described for the determination and portrayal of segregation in steel, using x-ray fluorescence probe analysis. Extensive modifications to a standard x ray fluorescence analyzer included a mechanism enabling specimens to be traversed automatically under the x-ray beam. Using this equipment to investigate dendritic segregation of chromium in a steel sample, it was possible to produce a contour map of chromium content; this was successfully correlated with the dendritic structure observed by metallographic means. The application and limitations of the technique are critically discussed. (auth)

11245 ALLOYS OF U WITH LOW V CONCENTRATIONS: REFINING OF THE GRAIN AND MECHANICAL PROPERTIES. Reisse, Robert; Collot, Claude; Francois, Dominique (CEA, Paris). Compt. Rend., Ser. C, 263: 1348-51(Nov. 28, 1966). (In French).

Binary U-V alloys with V concentrations between 0.10 and 0.25 wt % were studied. The alloy with 0.20% V had in the crude-cast state a fine-grained structure. Its mechanical characteristics at room temperature were determined. (tr-auth)

11246 NIOBIUM-NICKEL SYSTEM. Kornilov, I. I.; Pylaeva, E. N. Izv. Akad. Nauk SSSR, Metal., No. 5, 132-6(Sept.-Oct. 1966). (In Russian).

A phase diagram of the Nb-Ni system has been plotted on the basis of data obtained by physicochemical analysis of 31 alloys containing from 26.5 to 100 at. % Nb. Alloys were melted from 99.7%-pure Nb and N-00-grade pure Ni. Two compounds were identified: Nb_3Ni formed at 1,350°C by a reaction between two solid solutions, and NbNi formed at 1570°C which dissolves 49 to 61 at. % of Nb at 800°C. The solubility of Ni in Nb was found to be: 8 at. % at 1570°C, 4 at. % at 1400°C, 2 at. % at 1200°C, about 1.5 at. % at 1000°C, and 1 at. % at 800°C. The hardness of the alloy increases with increasing Ni content and reaches its maximum of about 640 kg/mm² at 40 at. % Ni. (ATD)

11247 CONSTITUTION DIAGRAM OF THE Al-Be-Mg SYSTEM. Nagorskaya, N. D.; Goldenberg, A. E.; Novoselova, A. V.; Borisova, A. P.; Fridlyander, I. N.; Yatsenko, K. P. Izv. Akad. Nauk SSSR, Metal., No. 5, 137-47(Sept.-Oct. 1966). (In Russian).

Constitution diagrams of Al-Be-Mg alloys with 0.6, 10, 20, 30, and 50 wt % Be were constructed and analyzed. (R.V.J.)

11248 TERNARY Mo-Co-Si SYSTEM. Skolozdra, R. V.; Gladyshevskii, E. I.; Yarmolyuk, Ya. P. Izv. Akad. Nauk SSSR, Metal., No. 5, 148-51(Sept.-Oct. 1966). (In Russian).

A study has been made of 120 alloys of the Mo-Co-Si system. Alloys were melted from 99.9%-pure Mo, 99.98%-pure Co, and 99.99%-pure Si. A phase-equilibrium diagram of the system at 800°C was plotted on the basis of data obtained by physicochemical analysis. The existence of the MoCoSi compound, with a homogeneity region extending from 15 to 30 at. % Si, was confirmed. Two previously unknown compounds, $Mo_5Co_3Si_2$ ($\alpha = 11.06$ Å, $c = 19.89$ Å) and Mo_3CoSi ($\alpha = 12.70$ Å, $c = 4.85$ Å), were found. The

solubility of Co in MoSi was about 3 at. % and in Mo_5Si_3 and Mo_3Si, about 5 at. %. The solubility of Si in Mo_6Co_7 was 12 at. % and in $MoCo_3$, less than 5 at. %. The solubility of Mo in silicides was found to be insignificant. (ATD)

11249 NIOBIUM AND VANADIUM CRYSTAL STRUCTURE AT HIGH TEMPERATURES. Vasyutinskii, B. M.; Kartmazov, G. N.; Smirnov, Yu. N.; Finkel, V. A. (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Fiz. Metal. Metalloved., 21: 620-1(Apr. 1966). (In Russian).

A high-temperature x-ray analysis of Nb and V crystal structure at 20 to 2400°C and 20 to 1650°C, respectively, did not reveal any structural transformations or anomalous lattice parameters. The measurements of crystal-structure parameters as a function of temperature were calculated by the method of least squares. (R.V.J.)

11250 EFFECT OF NIOBIUM ON SOLID-STATE TRANSFORMATIONS IN ALLOYS OF THE VANADIUM–TANTALUM SYSTEM. Grigorev, A. T.; Sokolovskaya, E. M.; Nefedov, A. P.; Sokolova, I. G. Izv. Akad. Nauk SSSR, Metal., No. 3, 183-92(May-June 1966). (In Russian).

An attempt was made to determine the nature of the influence of Nb on solid state transformations in V–Ta alloys in the region of the metallic compound TaV_2. Both annealed (ordered) and quenched (from 1000, 1150, 1250, and 1400°C) alloys were investigated by physicochemical techniques (microscopic and high-temperature contactless thermal analyses, hardness and microhardness measurements, determination of temperatures of starting fusion). On the basis of the data obtained, phase diagrams of the V–Ta–Nb system in a radial section with a constant ratio (at. %) V : Ta = 2 : 1 and in two polythermal sections (with 10 and 5 at. % Nb) were plotted, and the distribution of the phase regions was established in the ternary system at various temperatures. According to x-ray data, the crystal structure and lattice constants of the ternary ordered phase do not differ from those of the metallic compound TaV_2. (ATD)

11251 ELECTRICAL RESISTANCE AND THERMAL EXPANSION OF ALLOYS OF THE Ti–Nb–Cr SYSTEM. Kornilov, I. I.; Shakhova, K. I.; Budberg, P. B. Izv. Akad. Nauk SSSR, Metal., No. 3, 172-8(May-June 1966). (In Russian).

The electrical resistance of alloys of the Ti–Nb–Cr system was investigated as a function of their chemical and phase composition at room temperature and during heating to 1100°C. The thermal expansion in the 20 to 1100°C range was also studied. The alloys were first quenched from 1000°C and subjected to prolonged annealing. Data on the variation of the electrical resistance with the composition were found to be in good agreement with the results of microstructural and x-ray phase analyses. The electrical resistance data for the 20 to 1100°C range permitted the determination of the temperature boundaries of existence of the phase regions. Transition from one phase region to another was indicated by the presence of breaks in the curves of electrical resistance vs temperature. A study of the thermal expansion of alloys during heating made it possible to establish the temperatures of transitions in the solid state. It is shown that eutectoid-type phase transitions take place very slowly in the alloys studied. (ATD)

11252 DETERMINATION OF THE LIMITS OF JOINT SOLUBILITY OF NEODYMIUM AND NICKEL IN SOLID MAGNESIUM. Drits, M. E.; Bochvar, N. R. Dokl. Akad. Nauk SSSR, 169: 884-6(1966). (In Russian).

In order to determine the limits of joint solubility of Nd and Ni in solid Mg, isothermal sections of the Mg–Nd–Ni diagram were plotted at 430, 400, and 250° on the basis of microscopic and chemical analyses of the alloys and measurements of their electrical resistance. All the sections intersect six phase regions: a single-phase region of a solid solution of Nd and Ni in Mg, three two-phase regions $\alpha + Mg_9Nd$, $\alpha + X$ and $\alpha + Mg_2Ni$, and two three-phase regions $\alpha + Mg_9Nd + X$ and $\alpha + X + Mg_2Ni$. It was found that the introduction of Ni into Mg–Nd alloys decreases the solubility of Nd in Mg, whereas the introduction of Nd into Mg–Ni alloys leaves the solubility of Ni in Mg virtually unchanged. As the temperature drops, the relative positions of the phase regions change: the single- and two-phase regions narrow down, and the three-phase regions widen. From the microstructural studies, the separate and joint solubilities of Nd and Ni in solid Mg were determined at 430, 400, and 250°C. The electrical resistance measurements confirmed the microstructural data. (ATD)

11253 SCANDIUM–RHENIUM SYSTEM PHASE DIAGRAM. Savitskii, E. M.; Tylkina, M. A.; Khamidov, O. Kh. Izv. Akad. Nauk SSSR, Metal., No. 4, 116-22(July-Aug. 1966). (In Russian).

A phase diagram of the Sc–Re system has been plotted on the basis of data obtained by physicochemical analysis of 13 alloys containing 0 to 100% Re, melted from sintered 99.98%-pure Re and distilled 99.4 to 99.6%-pure Sc. The diagram is of the peritectic type with two intermetallic compounds, $ScRe_2$ and Sc_5Re_{24}, and limited solubility of components. The solubility of Sc in Re is approximately 2% Sc at peritectic temperature and decreases insignificantly at lower temperatures. The Sc_5Re_{24} compound has a cubic lattice with a constant a = 9.6448 Å and a microhardness of 1225 kg/mm². The $ScRe_2$ compound of the Laves type has a hexagonal, close-packed lattice with constant a = 5.270 Å, and a microhardness of 930 kg/mm². Scandium-base solid solution and $ScRe_2$ compound form a eutectic at 1360°C which contains approximately 1% Re. (ATD)

11254 CONSTITUTION DIAGRAM OF THE TERNARY W–Zr–Ti ALLOY. Zakharov, A. M.; Savitskii, E. M. Izv. Akad. Nauk SSSR, Metal., No. 5, 159-68(Sept.-Oct. 1966). (In Russian).

Microscopic, microhardness, thermal, and x-ray-phase analyses were made of polythermal cross sections of the ternary W–Zr–Ti alloys with the ratio of W : Zr = 4 : 1 and 1 : 1 and 10 to 30 wt % Ti. Isothermal cross sections were constructed at 1500 and 1000°C. Combined solubility of W and Zr in β–Ti solid solutions is reduced with reduced temperature (thus, W and Zr solubility in β–Ti across Ti–W_2Zr cross section is 43 to 44 wt % at 1500°C and 35 to 36 wt % at 1000°C). Additions of Ti increase W diffusion into β-Zr at 1500 and 1000°C. (R.V.J.)

11255 NUCLEAR FUEL MATERIALS. Bellamy, Roy Graham (to United Kingdom Atomic Energy Authority). U. S. Patent 3,285,737. Nov. 15, 1966. Priority date Dec. 17, 1963, Great Britain.

Alloys of U were developed for use as nuclear fuel materials that resist the formation of large bubbles of fission product gases at the grain boundaries. These alloys contain 100 to 1500 ppM of Al and a corresponding addition of at least one grain refining element selected from the group consisting of Cr, Mo, Rh, Co, Ir, Os, Re, Ru, Ni, Pt, W, V, and Mn, to give a grain size not exceeding 0.5 mm with the balance being U and incidental impurities. The alloys are quenched from the β-phase and subsequently annealed in the α-phase. Two specific alloys are patented. These are U-base, 100 to 1500 ppM Al, and 200 to 500 ppM Si and U-base, 100 to 1500 ppM Al, and 200 to 500 ppM Nb. (B.L.M.)

Radiation Effects

Refer also to abstracts 11169, 11174, 11175, 11189, 11190, 11208, and 12141.

11256 (AE–260) HIGH TEMPERATURE TENSILE PROPERTIES OF UNIRRADIATED AND NEUTRON IRRADIATED 20Cr–35Ni AUSTENIC STEEL. Roy, R. B.; Solly, B. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Dec. 1966. 25p. Dep. mn.

The tensile properties of an unirradiated and neutron irradiated (at 40°C) 20% Cr–35% Ni austenitic steel have been studied at 650, 750, and 820°C. The tensile elongation and mode of fracture (transgranular) of unirradiated specimens tested at room temperature and 650°C were almost identical. At 750 and 820°C the elongation decreased considerably and a large part of the total elongation was non-uniform. Furthermore, the mode of fracture at these temperatures was intergranular and microscopic evidence suggested that fracture is caused by formation and linkup of grain boundary cavities. Yield strength (YS) and ultimate tensile strength (UTS) decreased monotonically with temperature. Irradiated specimens showed a further decrease in ductility and an increase in the tendency to grain boundary cracking. Irradiation had no significant effect on the YS, but the UTS were reduced. The embrittlement of the irradiated specimens was attributed to the presence of He and Li atoms produced during irradiation and the possible mechanisms are discussed. Prolonged annealing of irradiated and unirradiated specimens at 650°C appeared to have no significant effect on tensile properties. (auth)

11257 (AECL–2625) THE EFFECT OF FAST NEUTRON IRRADIATION ON THE TENSILE PROPERTIES OF SPECIMENS FROM COLD-WORKED ZIRCONIUM–2.5 WT PERCENT NIOBIUM PRESSURE TUBES. Parry, G. W. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Nov. 1966. 20p. Dep. mn. AECL $0.50.

Transverse and longitudinal tensile specimens from two cold-worked Zr–2.5 wt % Nb pressure tubes were irradiated in a fast-neutron rod at 300°C. Irradiation increased the yield and ultimate tensile strengths and decreased the ductilities to about 50% of the unirradiated values. A greater % increase in yield strength was observed in the longitudinal specimens. This effect of irradiation on slip and twinning deformation systems is discussed. The effect of H_2 concentrations up to 200 ppM in unirradiated and irradiated specimens was small. (auth)

11258 (EURAEC–1726) INFLUENCE OF NITROGEN IN IRON AND STEEL UNDER FAST NEUTRON IRRADIATION. Quarterly Report No. 1, October 1–December 31, 1965. (Societa

Ricerche Impianti Nucleari, Saluggia (Italy). Centro Ricerche Nucleari). Sept. 1966. Contract 075-65-10-TEEI-RD. 10p. (EUR-2898). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The influence of N_2 on neutron-irradiated Fe and steels was studied. Irradiation was performed and a better design for the irradiation container was studied to avoid undesired temperature increases. Specimens have been prepared from ASTM A 212 B steel melts suitably prepared with different killing elements. Study of the neutron spectrum influence on the radioinduced changes in mechanical and magnetic properties was begun. The possibility of using magnetic property changes of iron alloys as a detector of radiation damage was examined. (auth)

11259 (EURAEC-1727) INFLUENCE OF NITROGEN IN IRON AND STEEL UNDER FAST NEUTRON IRRADIATION. Quarterly Report No. 2, January 1–March 31, 1966. (Societa Ricerche Impianti Nucleari, Saluggia (Italy). Centro Ricerche Nucleari). Sept. 1966. Contract 075-65-10-TEEI(RD). 9p. (EUR-2899). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The effects of fast neutrons on mechanical properties of Fe–Ti and Fe–N–Al alloys, before and after isothermal annealing, were investigated. Heat treatment at 300°C was prolonged up to 300 hr in order to study possible secondary embrittlement. Tensile tests were made on Fe–Ti specimens irradiated at 0.7 and 2×10^{18} n cm^{-2}. (P.C.H.)

11260 (N-66-32433) SURFACE BLISTERING OF METALS BY ION BOMBARDMENT. Final Report, March 1964–April 1965. (Avco Corp., Tulsa, Okla. Oklahoma Univ. Research Inst., Norman). Aug. 1965. Contract NASw-920. 30p. (NASA-CR-76757; TR-65-352-F). CFSTI $3.00 cy, $0.65 mn.

Ingots of 99.999% pure aluminum were irradiated with mass analyzed proton and hydrogen ion beams. The irradiated materials were subsequently annealed at various temperatures for different durations and observed by photomicrography. Variation of proton energy and sample purity showed predictable results; however, the effects of sample temperature, proton flux, and oxide layer thickness have yet to be determined. The size of blisters and degree of segregation appears to be related to sample purity and degree of cold work. Additional studies involving aluminum and gold are underway. (auth)

11261 (NP-16522) RADIATION EFFECTS ON SOLID, URANIUM BASED NUCLEAR FUEL MATERIALS. Vol. 6, No. 2. A Bibliography. Nystroem, A. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Dec. 1966. 57p. Dep. mn.

Abstracts are presented for 141 references on radiation effects on solid, uranium based nuclear fuel materials. Subject, coordinate, publications, and corporate author indexes are included. (M.C.G.)

11262 (ORNL-4056) SWELLING OF UAl_3–Al COMPACTS. Gregg, J. L.; Crouse, R. S.; Werner, W. J. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Irradiation testing of ATR- and HFIR-type fuel elements containing dispersed UAl_3 in Al showed them less likely to swell or blister than oxide dispersions. However, swelling did occur in the fabrication of these types of fuel elements when the cold-pressed core materials, cold pressed to high density, were vacuum degassed at 590°C. Longitudinal dimensional changes to 8% were found in $\frac{1}{2}$-in.-dia by $\frac{1}{2}$-in.-high cylindrical pellets. Examination by low-magnification microscope, room-temperature and heating-stage metallography, and x-ray diffraction confirmed the transformation of UAl_3 to UAl_4. Very little volume change occurs when UAl_3 converts to UAl_4 in an Al matrix, so the swelling was thought to take place due to fuel particles changing shape and forcing the poorly bonded Al grains apart. This shape change and wedging process was observed in a heating-stage metallograph. (auth)

11263 (WAPD-TM-595) EVALUATION OF THE IRRADIATION PERFORMANCE OF ZIRCALOY-4 CLAD TEST ROD CONTAINING ANNULAR UO_2 FUEL PELLETS (ROD 79-19). McCauley, J. E.; Daniel, R. C.; Meieran, H. B.; Engel, J. T. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Dec. 1966. Contract AT(11-1)-Gen-14. 105p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A Zircaloy-4 sheathed, rod type fuel element, containing relatively high density (95.7% TD) UO_2 annular fuel pellets, was irradiated to a depletion of 13.7×10^{20} fissions per cm^3 of 100% dense fuel at average peak pellet temperature of 1655°F (904°C). The specimen failed in the reactor and developed a $1\frac{3}{4}$ inch long crack in the cladding. The depletion limit dictated by the failure of this element applies only to the indicated test environment and to a specific test design that deliberately minimized the gap between fuel and cladding. The fuel to cladding gap was made as small as possible so that fuel swelling characteristics could be inferred from cladding dimensional measurements. It is judged that a net plastic strain leading to sheath rupture was developed in the cladding by radioinduced swelling of the ceramic pellets concomitant with the plastic strains encountered from rod bowing. Reasonable agreement was obtained between measurements and calculations of fuel and cladding deformation as a function of irradiation lifetime. These calculations were made with an analysis method incorporated in the CYGRO-2 digital program and with a consistent set of materials' properties selected to yield overall agreement with these and other bulk oxide irradiation test results. The materials' properties and other input parameters and assumptions are presented in detail. An extensive metallographic evaluation was completed of the fuel and cladding subsequent to element failure. Theoretical models were employed to obtain estimates of UO_2 grain growth, and as-fabricated void and gas bubble migration. Calculated behavior of these parameters was consistent with observed microstructural features in the ceramic fuel pellet. (auth)

11264 CHANGE OF RESISTIVITY BY ANNEALING OF NICKEL IRRADIATED WITH ALPHA PARTICLES. Dekhtyar, I. Ya.; Mikhalenkov, V. S.; Pilipenko, V. V.; Silantev, V. I. At. Energ. (USSR), 21: 465-70(Dec. 1966). (In Russian).

The kinetics of resistivity of nickel irradiated by 12.4-Mev α particles was investigated at various annealing temperatures. Kinetic curves exhibit at 700°C and above a certain rise and then decrease. Such a course is in agreement with the general behavior of saturated solid solution disintegration and is related to the emission of helium-filled pores. The data agree with the theoretical calculations of the mechanism and kinetics of transformations during the decay of saturated metal solutions-inert gas. The mean value of emitted gas pores was ~140 Å and did not depend on the annealing temperature. (tr-auth)

11265 VOIDS AT DISLOCATIONS IN IRRADIATED TUNGSTEN. Attardo, M. J.; Galligan, J. M. (Brookhaven National Lab., Upton, N. Y.). J. Appl. Phys., 38: 418-19(Jan. 1967).

Field ion microscopic observations are presented on annealed tungsten which was irradiated by fast neutrons at 70°C. They show isolated voids at or around dislocations in the irradiated tungsten, whereas no such voids were observed in unirradiated specimens. It is concluded that the voids were not formed by thermal motion of vacancies to the dislocations. (D.L.C.)

11266 ENERGY DEPENDENCE OF FISSION-FRAGMENT DAMAGE IN GOLD FILMS. Merkle, K. L. (Argonne National Lab., Ill.). J. Appl. Phys., 38: 301-9(Jan. 1967).

Transmission electron microscopy was used to study the effects of fission-fragment irradiation on single crystalline gold films as a function of the fission-fragment energy. It is found that the density of black spots increases as the average energy of the fission fragment decreases. The observations indicate that black spots are produced in displacement cascades initiated by energetic primaries. The results are consistent with a model based on the assumption that only those events are observed in which the primary energy is greater than 2.5×10^4 eV. (auth)

11267 EMBRITTLEMENT OF NEUTRON-IRRADIATED 20Cr–25Ni–Nb AUSTENITIC STEEL AT 650 DEG C. Roy, R. B.; Solly, B. (Aktiebolaget Atomenergi, Studsvik, Sweden). J. Iron Steel Inst. (London), 205: 58-61(Jan. 1967).

The embrittlement of neutron-irradiated tensile specimens of 20Cr–25Ni–Nb steel at 650°C has been studied by means of electron microscopy. The tensile elongation of the irradiated specimens was reduced by 50%, the reduction being mainly in the uniform part of the elongation. Yield stress was increased considerably. The observed loss of ductility at this temperature does not appear to be due to the formation of helium bubbles at the grain boundary, and experimental evidence for the presence of bubbles is also lacking. It is suggested that at 650°C the ductility loss in the irradiated material is mainly due to the presence of irradiation-modified precipitates within the grains and at the grain boundaries. (auth)

11268 RADIATION DAMAGE IN INCOLOY-800. Busboom, H. J.; Comprelli, F. A.; Spalaris, C. N. (General Electric Co., San Jose, Calif.). Nucl. Appl., 2: 486-8(Dec. 1966).

The tensile properties of Incoloy-800 were studied after irradiation in either thermal-fast or fast-neutron spectrums. A general decrease in elevated temperature postirradiation ductility was observed. Similar radiation-induced embrittlement occurred for both thermal-fast and fast-neutron irradiation. The observed embrittlement was more dependent on postirradiation test temperature than irradiation temperature. (auth)

11269 DETERMINATION OF THE ROLE OF IN-PILE RADIATION ON THE MECHANISM OF PLASTIC DEFORMATION

OF EXTRA-SOFT STEEL BY MEASURING THE VOLUME OF ACTIVATION. Milasin, N. (CEN, Saclay, France). J. Nucl. Mater., 20: 334-6(Sept. 1966). (In French).

The elastic limit was studied as a function of the test temperature in an extra-soft steel before and after irradiation; simultaneously the activation volume was determined for control and irradiated samples in a wide temperature region in order to obtain new data on the plastic deformation mechanism. The elastic limit was also studied as a function of the temperature of samples irradiated and annealed at 250°C. In the control samples the curve giving the elastic limit as a function of temperature has the form typical of all the body-centered transition metals. The values of the activation volume are in good agreement with the results of other authors. In the case of irradiated samples, the results obtained show a significant increase of the athermal stress components. At the same time, the curve of variation of the elastic limit as a function of the temperature is modified and different activation volumes were found at all test temperatures. This is interpreted as an increase of the stress due to athermal mechanisms and also to the presence of another thermally activated process. Annealing the samples after irradiation causes a supplementary softening. Tempering seems to cause an increase of the athermal stress component. (J.S.R.)

11270 STUDIES OF IRRADIATION EFFECTS ON SWEDISH STEELS. Grounes, M. (Aktiebolaget Atomenergi, Sweden). Nucl. Eng., 11: 866-8(Nov. 1966).

Work on steels for the Swedish PWR and BWR power reactors is reviewed. Results of studies of radiation effects on the impact-energy transition temperatures of pressure vessel steels are shown graphically. A survey is also made of work on stainless steels and Ni-base alloys as pressure tube materials. (UK)

11271 INTEGRAL-OPERATOR METHOD FOR RESOLVING A CREEP PROBLEM IN IRRADIATED SOLIDS. Datkaev, A. M.; Rozovskii, M. I. pp 174-9 of Uravneniya Matematicheskoi Fiziki i Funktsiona Lnyi Analiz. Zhautykov, O. A. (ed.). Alma-Ata, USSR, Izdatelstvo Nauka Kazakhskoi SSR, 1966. (In Russian).

A problem of continuous creep of thick-walled pipe at high-temperature following irradiation by a surface neutron stationary flux with an identical mean energy and intensity was analyzed. A nonlinear integral equation with parameters discribing radioinduced heterogeneity of the material is used as the initial physical function. The problem was resolved by an integral-operator method. (tr-auth)

11272 LARGE MAGNETIZATION JUMPS IN IRRADIATED MOLYBDENUM PERMALLOY. Vasilev, B. V.; Gorelov, A. P. JETP Lett. (USSR) (Engl. Transl.), 4: 278-80(Nov. 15, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 4: 413-16(Nov. 15, 1966).

An investigation was made of the effects of neutron irradiation on the magnetization curve of permalloy with composition 79% Ni, 4% Mo, and 17% Fe. The sample was a bundle of 30 wires ~20-mm long and 50-μ diameter each, placed in a BeO capillary for protection against mechanical damage. Hysteresis loops are given for the samples after one-hour annealing at temperatures ranging from 20 to 400°C. The results show that irradiation of samples with fast neutron fluxes at a temperature close to 30°C has little effect on their magnetic properties. (M.O.W.)

Ceramics and Cermets

Refer also to abstracts 12142 and 12231.

11273 CERAMICS AND ENGINEERING. Rotsey, W. B.; Wright, W. J. (Australian Atomic Energy Commission). At. Energ. Austral., 9: No. 3, 2-5(July 1966).

Ceramics have found engineering applications at high temperatures, but these applications are restricted by two limitations in their mechanical performance, namely, their catastrophic fracture and variable strength. The problems of structure and the effects of sintering on properties are discussed with BeO as a specific example. Finally, the problem of measuring the strength of ceramics is considered. It is concluded that ceramic components should be designed as simple shapes, that they be used under compression rather than tension where possible, that behavior variations be minimized by careful fabrication procedures, and that component testing under actual service conditions is necessary. (D.L.C.)

11274 PYROLYTIC GRAPHITE. Moore, A. W. (Philips Research Labs., Eindhoven, Netherlands). Ned. Tijdschr. Natuur., 32: 221-32(July 1966).

A review is given of the production and properties of pyrolytic graphite, a dense, highly anisotropic graphite formed by the pyrolysis of hydrocarbons. After recrystallization at high temperatures, this material obtains most of the properties of single crystal graphite. Deposited and recrystallized pyrolytic graphite is not only of great interest in fundamental research on substances with highly anisotropic physical properties, but it has also found novel technological applications. (auth)

Preparation and Fabrication

Refer also to abstracts 11189, 11191, and 11194.

11275 (AAEC-TM-333) FABRICATION OF BERYLLIA-COATED, FUELLED BERYLLIA SPHERES FOR IN-PILE FISSION PRODUCT RELEASE TESTS. Reeve, K. D.; Clare, T. E.; Silver, J. M.; Bridgford, K. C. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). July 1966. 25p. Dep. mn.

Three sets of BeO-coated fuelled BeO spheres were made for fission product release testing in a sweep capsule irradiation rig. Results of various pre-irradiation tests are presented and discussed, and a summary of fission gas release results is included. Gas release rates were expected to vary inversely as the BeO density. However, the release rate was lowest for the loading with an intermediate density and was highest for that with the highest density. One or more of several structural factors may have changed the behavior from that expected. (auth)

11276 (EUR-3170.f) PREPARATION DES CARBURES D'URANIUM ET DES CARBURES MIXTES (URANIUM-ZIRCONIUM) PAR CONVERSION DIRECTE DES HALOGENURES EN CARBURES. (Preparation of Uranium Carbides and Mixed (Uranium-Zirconium) Carbides by Direct Conversion of Halides). Beucherie, P.; Payrissat, M.; Wurm, J. G. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1966. 54p. (In French). Dep. mn.

The direct conversion of halides to carbides was investigated by the following series of reactions: Carburization reactions of U halides (chlorides or fluorides) with a mixture of graphite and reducing metal (Mg, Ca, Al); carburization reactions of fluoride mixtures (U and Zr) with a reducing metal and graphite in order to form polycarbides. Both reaction series were investigated for their criteria of product quality and efficiency. The reactions of carburization were initiated under inert atmosphere at normal pressure; once the carbide was formed, the excess of the reducing metal and its halide were driven off under vacuum. The method has important applications in the production of enriched uranium carbide, preparation of polycarbides, and as a complementary tail end process for halide volatility reprocessing purposes. (auth)

11277 (NUMEC-3505-21) PuO_2-UO_2-ZrO_2 FUEL DEVELOPMENT PROGRAM. Progress Report, July 1, 1966-September 30, 1966. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Contract AT(30-1)-3505. 16p. (EURAEC-1767). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

Developments in studies on the performance capability of selected compositions from the fuel system PuO_2-ZrO_2-UO_2 are reported. Information is given on synthesis of the fuel material powders, fabrication of pellets, characterization of powders and pellets, and irradiation performance testing of selected fuel compositions. Data are tabulated. (P.C.H.)

11278 (NYO-3713-2) STUDIES OF THE PREPARATION OF MIXED CARBIDE FUEL UTILIZING COPRECIPITATION. Quarterly Progress Report No. 2, September 1, 1966-November 30, 1966. McMurtry, C. H.; Taylor, K. M. (Carborundum Co., Niagara Falls, N. Y. Research and Development Div.). Contract AT(30-1)-3713. 13p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work is being done on the synthesis of (U,Pu)C using a coprecipitation process and on the process variables affecting the reproducibility of this method. An apparatus and procedure were developed for carrying out the initial stages of this process. This included coprecipitation by evaporation, condensation of the acid fumes, dehydration and decomposition of the coprecipitated reactants in a controlled atmosphere to 600°C. Non-uniform heating rates up to 600°C were identified as the process variable resulting in poor reproducibility in the final carbide product. Automatic control of the rate of temperature rise to 600°C resulted in good reproducibility in carbide synthesized from uranyl nitrate-sucrose solutions. The success of this technique can be seen in the analyses of three duplicate carbide products which had total carbon contents of 6.94, 7.02, and 6.93 percent, respectively. Synthesis of $(U_{0.8}, Pu_{0.2})C$ was carried out using the apparatus and procedure developed during the study of process variables. Two additional organic compounds, furfural and phenylformaldehyde resin, were evaluated as sources of carbon. (D.L.C.)

11279 (UNC-5117) STUDY OF URANIUM-PLUTONIUM MONOXIDES. Progress Report, November 1, 1964-March 31,

1965. Stahl, D.; Strasser, A. (United Nuclear Corp., White Plains, N. Y. Development Div.); Andersen, J.; Taylor, K. (Carborundum Co., Niagara Falls, N. Y.). Apr. 15, 1965. Contract AT(30-1)-3305. 53p. (EURAEC-1367). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Dense essentially single phase (UPu)(OC) was produced by reacting UO_2 and PuO_2 with C or U metal with carbon stabilizer. The maximum oxygen content in the $(U_{0.9}Pu_{0.1})(OC)$ structure was found to be 0.58 atoms. (UPu) (OC) was found to be stable at high temperatures. Heat treatment at 1750°C in helium or vacuum did not change its structure or produce appreciable weight loss. (P.C.H.)

11280 (WAPD-TM-576) FABRICATION OF HIGH AND LOW DENSITY ThO_2 FUEL PELLETS. Hutchison, C. R.; Johnson, R. G. R. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Dec. 1966. Contract AT(11-1)-Gen-14. 65p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Characteristics of ThO_2 powder were evaluated in relation to sintered-pellet density. Open porosity in low-density ThO_2 fuel pellets was controlled by organic fugitive additions, which were removed by a thermal pretreatment prior to sintering. Of the several additives investigated, sucrose and dextrose offered the most promise for fabrication of pellets in the range of 75 to 85% of TD. Two pilot-scale pellet batches were made to check reproducibility of properties. Difficulties were encountered in producing pellets of uniform density in larger sizes (0.676-in. die size). (auth)

11281 (WAPD-TM-607) SINGLE-SINTER PROCESS FOR MANUFACTURING UO_2–ZrO_2 AND UO_2–ThO_2 FUEL PELLETS: A FEASIBILITY STUDY. Davis, R. T.; Hutchison, C. R. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Dec. 1966. Contract AT(11-1)-Gen-14. 34p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A single-sinter process would offer a major cost savings over the conventional double-sinter process for the production of binary oxide nuclear fuel pellets. In the former case, only the pellet is sintered, while in the latter case, both powder (for homogeneity) and pellet are sintered. Four methods were attempted on 32 to 36 wt % UO_2–ZrO_2 compositions: separate ball milling of the two powders and subsequent blending, simultaneous ball milling, simultaneous planetary milling, and simultaneous colloid milling. Simultaneous planetary milling was also tried on an 8 wt % UO_2–ThO_2 composition. The ball-milling methods were completely unsatisfactory in achieving density and U homogeneity. The planetary-milled pellets achieved density but not homogeneity. Colloid-milled pellets achieved density and fair homogeneity. Homogeneity was determined by electron microprobe and metallography techniques. No satisfactory pellets were fabricated with 8 wt % UO_2–ThO_2 composition by planetary milling both powders together. There are indications that the objective could be achieved with modification of the efforts described. (auth)

11282 (WAPD-TM-608) FABRICATION OF LOW DENSITY ANNULAR UO_2–ZrO_2 FUEL PELLETS. Davis, R. T. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Dec. 1966. Contract AT(11-1)-Gen-14. 31p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A study was made of various fabrication and product attributes versus density for 44 wt % natural UO_2–ZrO_2 annular cylindrical fuel pellets (and a quantity of 36 wt % natural UO_2–ZrO_2 pellets) with closed, rounded porosity. Solid-solution powder was prepared via the calcining-Majac milling operation. Ten 5-pound batches were agglomerated with different amounts of −140 +200 mesh dextrose ranging from 0 to 5.72 wt %. Each batch was compacted at two different green densities. As-sintered pellets were inspected for geometric density, open porosity, and dimensions, and analyzed chemically and examined by metallography. Some pellets from each processing condition were also centerless ground and inspected for dimension, geometric density, corrosion resistance and friability. The major problems encountered in fabricating satisfactory pellets were incomplete carbon burnout during pretreatment, difficulties in meeting the desired nominal densities, and difficulties in obtaining dextrose in the necessary size range. (auth)

11283 (WAPD-Trans-44) PROCESS FOR PRODUCTION OF A SINTERABLE URANIUM DIOXIDE. Verkerk, Barend. Translated for Bettis Atomic Power Lab., West Mifflin, Pa., from German Patent 1,208,743. 8p. Dep. mn. JCL $1.60 fs, $0.80 mf.

A process was developed for the preparation of sinterable UO_2 prepared through the reduction of U compounds at about 700 to 1000°C. The UO_2 is subjected to oxidation at about 700 to 1000°C in a steam-containing O_2-free atmosphere immediately after its preparation until a product is obtained having a composition between $UO_{2.02}$ and $UO_{2.08}$. This product is not pyrophoric, can be sintered well, and retains its composition on storage in air. Some examples are given. (M.C.G.)

11284 SYNTHESIS AND PROPERTIES OF MEAN ERBIUM, THULIUM, YTTERBIUM, AND LUTETIUM TUNGSTATES. Plyushchev, V. E.; Amosov, V. M. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 1460-6(Aug. 1966). (In Russian).

Reactions of Er_2O_3, Tm_2O_3, Yb_2O_3, Lu_2O_3, and WO_3 during high-temperature sintering were investigated. Optimum conditions for synthesis of $Er_2O_3 \cdot 3WO_3$, $Tm_2O_3 \cdot 3WO_3$, $Yb_2O_3 \cdot 3WO_3$, and $Lu_2O_3 \cdot 3WO_3$ were found and certain properties of the compounds are discussed. (R.V.J.)

11285 INVESTIGATION OF THE CONDITIONS FOR THE PREPARATION OF NIOBIUM CARBIDE AND NIOBIUM CARBONITRIDE FROM NIOBIUM PENTOXIDE. Meerson, G. A.; Rakitskaya, E. M.; Bulgakov, V. N.; Ladygo, A. S. (Moscow Inst. of Steel and Alloys). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 1429-33(Aug. 1966). (In Russian).

Preparation of NbC from Nb and NH_3 was studied at 1200 to 1700°C for 1 to 8 hrs and the preparation of $NbN_{0.3}C_{0.7}$ from NbO_5, C, and N_2 and from NbO_5 and C in an NH_3 atmosphere was studied at 1000 to 1700°C for 1 to 2 hrs. In general, it was found that higher temperatures and longer reaction durations led to higher nitrogen content in the NbC product. The experimental data as well as the thermodynamic calculations show that above 1620°C the NbC with less than 0.1% oxygen can be prepared from NbO_5 in an NH_3 atmosphere. The experimental data and the thermodynamic calculations also show that niobium carbonitride with as little as 0.01% oxygen content can be prepared from NbO_5, C, and NH_3. In general, the formation of nitrides and carbonitrides in NH_3 atmosphere was faster than in the N_2 atmosphere. This is explained in terms of the high reactivity of nitrogen atoms readily generated on oxide surfaces by the dissociation of ammonia. (ATD)

11286 PREPARATION OF URANIUM CHALCOGENIDE SINGLE CRYSTALS BY MEANS OF CHEMICAL TRANSPORT REACTIONS. Slovyanskikh, V. K.; Ellert, G. V.; Yarembash, E. I.; Korsakova, M. D. (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 973-5(June 1966). (In Russian).

The preparation of USe_2, USe_3, UTe_2, and US_2 single crystals from U metal and the chalcogenide in evacuated quartz ampoules with Br as the transport agent is described, and some data are presented on the conditions of their growth and morphology. The yield of the single crystals was studied as a function of the temperature, Br concentration, total amount of U present in the ampoule and the Te/U ratio. As the latter increases from 0.9 to 1.9, UTe_2 single crystals grow; above 1.9, UTe_3 crystals begin to grow. As the Te/U ratio increases the amount of the crystallizing UTe_3 increases. At Te/U ≤ 1.1, fine Si single crystals are formed together with UTe_2, and at Te/U = 0.7, practically only Si single crystals are formed. The dependence of the yield of UTe_2 crystals on the initial Br concentration was determined: in the range of low Br concentration, as the latter rises, the transport of U increases sharply and reaches a certain maximum value, then decreases and remains unchanged. UTe_2 single crystals were obtained in the form of blocks consisting of several single crystals, or in the form of individual single crystals. USe_3 and UTe_3 crystallized in the form of thin bands 1 to 2 mm wide and up to 20 mm long. USe_2 and US_2 single crystals were formed under conditions similar to those of UTe_2. (ATD)

11287 NEW RADIOLOGICAL SHIELD. Riedel, J. T. (Inst. of Nuclear Research, Warsaw). Int. J. Appl. Radiat. Isotop., 18: 134-5(Feb. 1967). (In French).

A new process for obtaining radiological shielding by use of a thermal plasma technique is discussed with particular reference to the use of refractory materials for neutron shielding purposes. The refractory powders are heated in contact with ionized gas to form the plasma fluid, then in an electric arc, and then torch-sprayed on to a base material. An example is the deposition of boron carbide on steel or aluminum. This gives a shield in which the boron carbide is partly diffused in the metal and partly forms a dense surface layer. (INIS-UK)

11288 THE DEPOSITION OF THIN FILMS OF ENRICHED URANIUM DIOXIDE. Baciarelli, Renato M. (Aerojet-General Nucleonics, San Ramon, Calif.). Nucl. Appl., 2: 471-6(Dec. 1966).

The application of a known technique was developed for preparing thin films of enriched UO_2 to be used in the study of energy deposition efficiency by fission fragment escape from radioactive sources being irradiated. Films were deposited on stainless steel sheet by vacuum vapor deposition, using an electron gun to vaporize the UO_2. The studies resulted in curves for rate of deposition

and uniformity of thickness as well as an experimentally derived formula which relates deposition parameters to uniformity of thickness. (auth)

11289 REINFORCED CERAMIC FUEL ELEMENTS. Jens, Wayne H. (to Atomic Power Development Associates, Inc.). U. S. Patent 3,285,825. Nov. 15, 1966. Filed Sept. 16, 1964.

A reinforced ceramic fuel element for nuclear reactors consists of compatible metal fibers held in parallel arrangement with the ceramic material during fabrication of the element. The metal fibers are kinked in a wavy sort of fashion throughout the ceramic material to eliminate the high stresses in the fibers due to the large expansion of the ceramic material, or of the ceramic particles fastened to a long metal string or rod. The ceramic component of the fuel element may be UO_2, PuO_2, UC, PuC, UN, or PuN, and some suitable metals are Mo, Ta, Nb, W, Fe, Ni, Cr, and Zr or their alloys. (B.L.M.)

11290 COMPOSITE STRUCTURES MADE BY BONDING CERAMICS, CERMETS, ALLOYS, HEAVY ALLOYS AND METALS OF DIFFERENT THERMAL EXPANSION COEFFICIENT. Zimmer, Frantisek (to Bureau d'Etudes Industrielles Fernand Courtoy). U. S. Patent 3,284,174. Nov. 8, 1966. Filed Apr. 16, 1962.

A method is described for producing a composite structure comprised of two spaced component parts and a connecting piece metallurgically bonded between the component parts. The component parts are selected from the group consisting of ceramics and metals, cermets and metals, cermets and super alloys, heavy tungsten alloys and metals, ceramics and cermets, and ceramics and super alloys. The connecting piece is at least one alloy formed by powder metallurgy and having a coefficient of expansion that varies substantially continuously from one end to the other. The coefficient of expansion of each end of the connecting piece substantially matches that at the adjacent end of the component piece to which it is to be bonded. The alloy is selected from the following group of alloys: Fe, 54 to 74%, Ni, 29 to 8%, Co, 17 to 0%, and Cr, 0 to 18%; Fe, 54 to 74%, Ni, 42 to 8%, and Cr, 0 to 18%; Zr, 100 to 0% and Ti, 0 to 100%; W, 94 to 0%, C, 6 to 0%, and Co, 0 to 100%; Ti, 81.5 to 0%, C, 18.5 to 0%, and Ni, 0 to 100%; W, 92 to 0%, Ni, 5 to 100%, and Cu, 3 to 0%; and Fe, 74 to 79.5%, Cr, 18 to 3.5%, Ni, 8 to 12%, and Mn, 0 to 5%. (B.L.M.)

11291 COMPOSITION AND METHOD FOR THE PREPARATION OF PRODUCTS OF MOLYBDENUM CARBIDE. Vachet, Pierre; Molinier, Rene (to Pechiney Compagnie de Produits Chimiques et Electrometallurgiques). U. S. Patent 3,277,222. Oct. 4, 1966. Priority date Nov. 6, 1962, France.

A method is described for the fabrication of objects, such as thin wall tubing, round and flat bars, or large objects, of MoC. Powdered or finely divided MoC is mixed with 1 to 10 wt % of carnauba or bee's wax and 5 to 20 vol % of a halogenated aliphatic hydrocarbon, such as CCl_4 or trichloroethylene. The mixture is heated and formed into a paste, which is cast into a mold and which sets upon cooling. The object is fritted by heating to a high temperature in an inert atmosphere or the bar can be extruded into the desired shape prior to fritting. (B.L.M.)

11292 METHOD OF MANUFACTURING A COMPOSITE, HEAT-INSULATING MATERIAL OF THE TYPE FORMED BY STACKING FOILS OF OXIDIZABLE METAL. Alfille, Lucien; Darras, Raymond (to Commissariat a l'Energie Atomique). U. S. Patent 3,284,256. Nov. 8, 1966. Priority date Oct. 10, 1960, France.

A method is described for forming a composite, heat-insulating material comprising layers of foils of an oxidizable metal in which each layer has at least one surface covered by a heat-insulating substance. A stack of alternately thick and thin foils of the same metal, either Mg or Al, having a low neutron absorption are wound around the object to be thermally insulated. The thickness of the thick foils is between 0.15 and 0.5 mm and the thickness of the thin foils is between 0.01 and 0.1 mm. The thin metallic foils are completely oxidized at an elevated temperature between 350 and 525°C in an atmosphere of CO_2 at a pressure between 15 and 60 kg/cm^2 to form a layer of the refractory oxide between the thick foils. The stack of foils may be reinforced by thin Zr ribbons. (B.L.M.)

Properties Evaluations

Refer also to abstracts 10368, 10369, 11189, 11191, 11208, 11277, 11279, 11561, and 11564.

11293 (AAEC-TM-335) OBSERVATIONS ON THE SINTERABILITY, STRENGTH, AND STRUCTURE OF VARIOUS GRADES OF BERYLLIUM OXIDE. Clare, T. E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Aug. 1966. 31p. Dep. mn.

Four sulfate-derived BeO powders from three different commercial sources have been isostatically pressed and sintered. These powders showed significant variations in sintering behavior which could be partially predicted by semi-empirical equations taking physical properties of the powder into account; the limitations of these equations are discussed. However, all powders showed microstructural defects when sintered. High strength is associated with high density, fine grained, and flawfree sintered materials, and the four powders examined could be placed in a high or low strength category from a cursory glance at their microstructure. (P.C.H.)

11294 (BMI-1789) THERMAL STABILITY OF ZIRCONIA-AND THORIA-BASE FUELS. Alexander, Carl A.; Ogden, Julius S.; Cunningham, George W. (Battelle Memorial Inst., Columbus, Ohio). Jan. 6, 1967. Contracts W-7405-eng-92; AT(11-1)-Gen-14; Subcontract 73-14-1216. 27p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Bettis Atomic Power Lab., Pittsburgh, Pa.

Vapor densities and/or dissociation pressures of UO_2, ThO_2, ZrO_2, ThO_2-8 and -20 wt % UO_2, and ZrO_2-20 and -50 wt % UO_2 were obtained in the range from 2000 to 3000°K by the transpiration technique. The UO_2-ZrO_2 system exhibited marked positive deviation from ideality, indicative of a strong tendency toward immiscibility. The UO_2-ThO_2 system was found to behave almost ideally. On the basis of the vapor pressures of UO_2 and of ThO_2 and the activity values it would be expected that compositions containing 1 mole % or more of UO_2 would volatilize by preferentially losing UO_2. A composition containing slightly less than 1 mole % UO_2 should prove to be the congruently subliming composition. O_2-dissociation pressures were determined for stoichiometric UO_2 and for a composition on either side of the stoichiometric one. At 2360°K, $UO_{2.03\pm0.01}$, $UO_{2.00\pm0.01}$, and $UO_{1.97\pm0.01}$ exhibited O_2-dissociation pressures of 1×10^{-7}, 4.3×10^{-10}, and 3×10^{-12} atm, respectively. From determinations of vapor density and measurements of O_2 pressure, pressure-temperature-composition relations were established for UO_2 over a small range of compositions encompassing $UO_{2.00}$. (auth)

11295 (EUR-3160.e) ISOTHERMAL IONIC MIGRATION IN MELTS. Forcheri, S.; Berlin, A. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1966. 24p. Dep. mn.

The application of thin-layer electrophoresis and diffusion on ceramic oxides (Al_2O_3, MgO, or ZrO_2) using radioisotopes to determine the isothermal transport quantities in molten salts is described. This technique utilized two different types of support layer for the electrolyte: powder deposited on fritted impermeable ceramic strips (Al_2O_3 or ZrO_2) or fritted porous ceramic material fixed on similar impermeable strips. The ionic mobilities and transport numbers were calculated by determining the displacement of the labeled zone, and the weight of the salt system on the strip, and coulometrically the quantity of electricity. The self-diffusion coefficients (trace-diffusion) were measured from the widening of the labeled zone and from the conductivity of the molten salt system on the strip. Measurement of the ionic mobilities and transport numbers required the knowledge of specific conductivities and densities of the elctrolyte. Some applications of this method to the investigation of molten nitrates are presented. The characteristics of methods of this kind as applied to the study of the molten systems are discussed. (auth)

11296 (KAPL-P-3177) IN-REACTOR MECHANICAL PROPERTIES OF NUCLEAR FUELS. Wisnyi, L. G.; Lovejoy, P. T.; Moyar, G. J. (Knolls Atomic Power Lab., Schenectady, N. Y.). Oct. 1966. Contract W-31-109-eng-52. 26p. (CONF-661001-40). DTIE.

From 14th Conference on Remote Systems and Technology, Pittsburgh, Pa.

Values for viscosity and yield strength are reported for four different nuclear fuel materials tested in reactor environment. These materials are UO_2, 2 wt % UO_2 in ThO_2, 10 wt % UO_2 in ThO_2, and 39 wt % UO_2 in ZrO_2. The tests were conducted at temperatures below which there would be a contribution of thermal creep, i.e., below 750°C (1382°F) and at fissioning rates between 4.0 and 7.6×10^{13} fissions/cc/sec in the solid fuel. The experiments consisted of compression tests at a strain rate of 1×10^{-5} in./in./hr and relaxation tests at constant strain. The data were interpreted by an analysis of the entire system including the cladding, fuel, and loading members. This investigation resulted in a direct measurement of in-reactor mechanical properties of nuclear fuel material. It was demonstrated that some materials have relatively low fission-induced viscosities in the order of 10^6 psi hrs while others have viscosities much greater, decades greater. At the higher viscosities the yield strength of the

material becomes increasingly important. A rheological model of a linear visco-elastic substance with a yield strength is adequate in describing the in-reactor performance of the nuclear fuel materials as tested in these experiments. (auth)

11297 (KFK-415) ZUR MESSUNG DER WAERMELEITF AEHIGKEIT VON FESTKOERPERN INSBESONDERE VON KERAMISCHEN KERNBRENNSTOFFEN BEI HOECHSTEN TEMPERATUREN. (Measurement of the Thermal Conductivity of Solids Especially of Ceramic Nuclear Fuels at High Temperatures). Spies, Johannes (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorbauelemente). Mar. 1966. 45p. (In German). Dep. mn.

The thermal conductivity of ceramic nuclear fuel is to be measured to give data for the development of mixed fuels with improved thermal conductivity and to permit the proper core design for these fuels. A method is proposed for the measurement of thermal conductivity at the fuel temperatures of 800 to 2,000°C encountered in a high temperature reactor, which, physically, is based upon the one-dimensional heat flow method. In this process, a disk-shaped specimen is heated on both sides by electron beams in vacuum. The temperatures of the sides of the specimen can be measured very accurately by a photoelectric pyrometer. The heat flow penetrating the specimen perpendicular to the disk areas owing to thermal conduction is determined by adjustment of two stationary states through the arising difference in the powers emitted onto a preset side of the specimen and reflected by it, respectively. The attainable accuracy in measurement of thermal conductivity is estimated to be ±5 percent for the case of measurement of heat flow through the powers dissipated by the specimen area. The apparatus can also be designed so that measurements of neutron-irradiated nuclear fuel material in a "hot cell" are possible by remote control. (auth)

11298 (KFK-435) VERGLEICH DER VERTRAEGLICHKEIT DER KERNBRENNSTOFFE UN, UC, UND UO_2 MIT METALLEN. (Comparison of the Compatibility of the Nuclear Fuel Materials UN, UC, and UO_2 with Metals). Goetzmann, O.; Thuemmler, F. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). June 1966. 16p. (In German). Dep. mn.

The compatibility of UN, UC, and UO_2 with Al, Be, Fe, stainless steel, Ni, Ni alloys, Ti, V, Cr, Zr, Mo, Nb, Ta, and W is outlined on the basis of a bibliographic study. (J.S.R.)

11299 (ORNL-TM-1596(Rev.)) THERMODYNAMIC FUNCTIONS OF NUCLEAR MATERIALS: UC, UC_2, UO_2, ThO_2, AND UN. Godfrey, T. G.; Woolley, J. A.; Leitnaker, J. M. (Oak Ridge National Lab., Tenn.). Dec. 1966. Contract W-7405-eng-26. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The thermodynamic functions, $H_T^0 - H_{298}^0$, C_p^0, S_T^0, and $(F_T^0 - H_{298}^0)/T$, of five compounds of nuclear interest (UC, UC_2, UO_2, ThO_2, and UN) have been calculated from literature data and tabulated at 100° increments. Estimates of accuracy are included. The fit of the original enthalpy data to the calculated curve is shown graphically in each case. (auth)

11300 (ORNL-TM-1705) COMPATIBILITY OF DISPERSION STRENGTHENED ALUMINUM WITH URANIUM MONOCARBIDE. A REVIEW OF THE LITERATURE. Venard, J. T. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 22p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Recent literature concerned with compatibility between dispersion-strengthened Al and UC was reviewed. Conclusions were drawn with particular reference to the performance of heavy-water moderated, organic-cooled reactor fuel elements. The conclusions summarize the current knowledge of the effect of temperature, the effect of fuel stoichiometry, the effect of protective anodized films, and the areas of uncertainty in the basic understanding of the compatibility reactions. (auth)

11301 (RM-5151-PR) THE THERMODYNAMICS OF THE BERYLLIA/BERYLLIUM-OXYGEN VAPOR SYSTEM. Krieger, F. J. (RAND Corp., Santa Monica, Calif.). Oct. 1966. Contract AF 49(638)-1700. 30p.

Thermodynamic investigations were made of BeO, over a range of temperatures up to 6000°K and pressures up to 10^3 atmospheres. Two sets of equilibrium composition equations are used, one representing a pure gas phase, the other a heterogeneous system of gas and condensed (i.e., solid or liquid) beryllia. The gas phase of the heterogeneous chemical system, like the homogeneous gas phase, comprises 15 gaseous beryllium-oxygen species. Results of the computational program are presented in both tabular and graph form. The latter is a conventional Mollier diagram in which specific enthalpy is plotted against specific entropy, with cross plots of temperature, pressure, and molecular weight or moles of condensed beryllia. (auth)

11302 (NP-tr-1494) CERAMICS REINFORCED BY FIBRES. Hoffmann, U. Translated by W. Bleyberg (Atomic Energy Research Establishment, Harwell, Eng.), from Ber. Deut. Keram. Ges., 43: 337-45(1966). 35p. Dep. mn. JCL $3.60 fs, $1.25 mf.

The present state of progress in the field of composite materials is reviewed, with emphasis on materials suitable for application at high temperatures, in particular fibre-reinforced ceramics. Recent work at the Battelle Institute is included. Topics covered include: general notes on materials reinforced by fibres, combinations of matrix and fibres, metallic fibres, ceramic fibres, influence of fibre on properties of materials (mechanical strength, resistance to temperature change, thermal conductivity, corrosion resistance), bonding between fibre and matrix, preparation, fields and opportunities for application, and experimental work (choice of materials, shaping, test for oxidation resistance). (UK)

11303 DEPENDENCE OF CERTAIN ELECTRO- AND THERMOPHYSICAL PROPERTIES OF ZIRCONIUM MONOCARBIDE ON THE CARBON CONTENT WITHIN THE RANGE OF HOMOGENEITY. Avgustinik, A. I.; Golikova, O. A.; Klimashin, G. M.; Neshpor, V. S.; Ordanyan, S. S.; Snetkova, V. A. (Leningrad Inst. of Tech. Semiconductor Inst., Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 1439-43(Aug. 1966). (In Russian).

The dependence of electrical resistivity, absolute thermal emf, Hall coefficient, and thermal conductivity of ZrC was studied for 36 to 48 atom % C contents in the carbide. The ZrC samples were prepared by fusing high purity Zr and C at 1800°C in vacuo followed by sintering at 2200°C. The properties, compositions, and lattice parameters for various Zr samples are graphed and tabulated. It was found that free electrons act as current carriers within ZrC. The electrical resistivity, the thermal emf, and the Hall coefficient were found to decline and the thermal conductivity was found to increase with declining contents of the combined carbon in ZrC. The phenomena are related to the release of a portion of the Zr electrons from the localized metal-carbon bonds. The specific resistivity and absolute thermal emf were found to increase linearly with increasing temperature. The slope of these lines was found to decrease with decreasing carbon content in $Zr(CO_3)_2$. This phenomenon is apparently due to the decline in the effective mass of the conduction electrons. (ATD)

11304 SUPERCONDUCTIVITY OF NbC-NbN SOLID SOLUTIONS. Shulishova, O. I. Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 1434-8(Aug. 1966). (In Russian).

A series of niobium carbonitrides containing 7.2 to 9.1% nitrogen and 3.4 to 3.5% carbon were synthesized and tested for superconductivity. It was found that the critical temperature of the carbonitrides is greatly affected by the composition. The highest critical temperature (T_k) of 17.9°K was obtained in a compound with the approximate formula $(NbC)_{0.30}$ $(NbN)_{0.70}$, which corresponds to about 4.85 valent electrons per atom. All the carbonitrides with compositions between $(NbC)_{0.2}$ $(NbN)_{0.8}$ and $(NbC)_{0.4}$ $(NbN)_{0.6}$ have a critical temperature of 17.4 to 17.8°K. It is noted that still higher values of T_k can be obtained with carbonitrides of stoichiometric composition (the niobium nitride in carbonitrides tested had the composition $NbN_{0.786}$-$NbN_{0.986}$). (ATD)

11305 MAGNON CONTRIBUTION TO THE LOW-TEMPERATURE SPECIFIC HEAT OF UO_2. De Batist, R.; Gevers, R.; Verschueren, M. (SCK-CEN, Mol, Belg.). Phys. Status Solidi, 19: 77-88(Jan. 1, 1967).

The contribution of acoustical phonons to the low-temperature specific heat of UO_2, as calculated from the single-crystal elastic constants, is much too small to account for the observed heat capacity. It is shown that this data can be explained in terms of antiferromagnetic magnons. An expression for the heat capacity due to spin waves is derived, firstly for a simple antiferromagnet having a spherically symmetric dispersion relation, and secondly for UO_2, where the dispersion relation is cylindrically symmetric. For UO_2 it is found that the next nearest neighbor interactions must be included in order to obtain a meaningful dispersion relation. (auth)

11306 STUDIES OF THE ELECTRICAL PROPERTIES OF URANIUM OXIDES. III. THERMOELECTRIC POWER OF α-U_3O_8. George, A. M.; Karkhanavala, M. D. (Atomic Energy Establishment, Trombay, India). Phys. Status Solidi, 19: 117-21(Jan. 1, 1967).

The thermoelectric power of nuclear pure α U_3O_8 is measured in air over the temperature range 100 to 850°C. The results show that the oxide is an n-type semiconductor. The plots of thermoelectric power versus the reciprocal of the absolute temperature consist of two regions: (1) above 480°C with a slope of 0.4 V and (2) below 480°C where the thermoelectric power shows considerable variations, the average slope being of the order of 0.01 V. The results are analyzed on the basis of the Wagner model for the defect structure of α U_3O_8. The slope of 0.40 V is related to the formation energy of the charge carriers, which is calculated to be 1.065 eV.

The low-temperature part of the plot probably shows the temperature dependence of the thermoelectric power due to frozen-in donor concentrations. (auth)

11307 CORRELATION OF MICROHARDNESS AND MICROBRITTLENESS OF REFRACTORY COMPOUNDS WITH THEIR ELECTRONIC STRUCTURE. Samsonov, G. V.; Stasovskaya, V. V. Porosh. Met., Akad. Nauk Ukr. SSR, No. 12, 95-9(Dec. 1966). (In Russian).

The microhardness and microbrittleness of refractory metal carbides and borides were measured on separate powder particles. An index of microbrittleness, which is equal to the product of reverse optimal loading by the change in the summary index of brittleness with increase of loading, is proposed. It was assumed that the microhardness and microbrittleness of the investigated refractory compounds are essentially conditioned by statistical weight of the stable electronic configurations of metal and nonmetal atoms and by the proportion of electrons transferred to the collectivizing state. (auth)

11308 POWDER METALLURGICAL ALLOY. Brinn, Walter K.; Barto, Ronald L. (to General Electric Co.). U. S. Patent 3,285,736. Nov. 15, 1966. Filed Aug. 27, 1964.

A powder-metallurgical Mo-base alloy was developed, which is strengthened by both solid solution and dispersion hardening to yield alloys with improved strength at elevated temperatures and that are workable at room temperatures. The alloys contain 0.1 to 1.0% ThO_2, about 5 to 30% W, and the balance Mo. The ThO_2 is dispersed in a substantially homogeneous W–Mo matrix phase. (B.L.M)

Structure and Phase Studies

Refer also to abstract 11293.

11309 (CEA-R-3060) LE SYSTEME URANIUM–DIOXYDE D'URANIUM A HAUTE TEMPERATURE. (The Uranium Dioxide–Uranium System at High Temperature). Guinet, Philippe; Vaugoyeau, Henri; Blum, Pierre (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1966. 20p. (In French). Dep. mn.

The liquidus curve was determined by a saturation method in which the thermal gradient was cancelled upon cooling, and the solidus curve by analyzing the deposits in equilibrium with the liquid at each temperature. The diagram, of a displaced eutectic type, presents a liquid immiscibility domain between 47 and 59 mole % of dioxide and a substoichiometry range UO_{2-x}; the minimum O/U ratio was 1.6 at 2470 ± 30°C. The monotectic composition was found by chemical analysis to be 59 mole % of dioxide and the reaction temperature 2470 ± 30°C. (auth)

11310 (AERE-Trans-1063) THERMOANALYTICAL AND X-RAY INVESTIGATIONS IN THE LEAD–TELLURIUM SYSTEM. Lugscheider, W.; Ebel, H.; Langer, G. Translated by H. B. Andrews (Atomic Energy Research Establishment, Harwell, Eng.), from Z. Metallk., 56: 851-2(1965). 6p. Dep. mn. BIS $0.25. HMSO 1s. 2d.

On the basis of results of thermoanalytical and x-ray measurements the Pb–Te phase diagram was amplified and corrected in a few points, and the lattice constant of the compound PbTe and its linear thermal coefficient of expansion were determined. (auth)

11311 LATTICE VIBRATIONS OF BeO. Brugger, R. M. (Phillips Petroleum Co., Idaho Falls, Idaho); Strong, K. A.; Carpenter, J. M. J. Phys. Chem. Solids, 28: 249-52(Feb. 1967).

Parts of the dispersion relations for BeO were measured. These relations were for waves moving in the [10$\bar{1}$0] direction with their polarization vectors in the (0001) plane. The initial slopes of the measured acoustical branches agreed with those obtained from ultrasonics. Branch intercepts at the zone centers of 84 MeV (1.27×10^{13} rad/sec) and possibly 5 MeV (8×10^{12} rad/sec) were found. The dispersion relations are correlated with infrared, Reststrahlen, and "frequency spectra" measurements and proposed models. (auth)

11312 REACTIONS OF SCANDIUM OXIDES WITH OXIDES OF CHROMIUM AND INDIUM. Pokrovskii, B. I.; Komissarova, L. I.; Vasileva, L. M.; Chechernikov, V. I.; Pechennikov, A. V. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 1524-6(Aug. 1966). (In Russian).

Magnetic and x-ray analyses of $Sc_2O_3-Cr_2O_3$ and $Sc_2O_3-In_2O_3$ systems revealed in the $Sc_2O_3-Cr2O_3$ system formation of the $3Sc_2O_3 \cdot Cr_2O_3$ compound with melting point at 2250 ± 50°C. It was found that the magnetic suseptibility of the compound as a function of temperature conformed to the Curie–Weiss law $\chi = 6.1 \times 10^{-3}/T + 23$; the Cr magnetic moment in $3Sc_2O_3 \cdot Cr_2O_3$ was found to be 3.8 ± 0.1 Bohr magneton. A metastable α-phase compound which disintegrates into $3Sc_2O_3 \cdot Cr_2O_3$ and a Cr_2O_3-base solid solution were found. It is shown that the $Sc_2O_3-In_2O_3$ system forms a continuous series of solid solutions with lattice parameters a linear function of the concentration. (R.V.J.)

11313 REACTIONS OF CARBIDES OF TRANSITION METALS WITH THEIR OXIDES. Kosolapova, T. Ya.; Fedorus, V. B.; Kuzma, Yu. B. (Inst. of Materials Science Problems, Academy of Sciences, Ukrainian SSR). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 1516-20(Aug. 1966). (In Russian).

The reactions of oxides of Ti, Zr, Hf, V, Nb and Cr with their carbides were studied in the range of 1000 to 2000°C (at 100°C intervals) at 10^{-3} mm Hg by using chemical and x-ray analyses. The formation of intermediate products was studied manometrically in certain reactions. In the TiO_2-TiC and ZrO_2-ZrC systems at 1000 to 2000°C, the reaction proceeds up to the formation of MC_xO_{1-x} oxycarbides. No reaction is observed in the HfO_2-HfC system in this temperature range. Carbides of group V metals VC and NbC, react with the corresponding oxides to form the metals via stages of formation of lower oxides and carbides. The formation of Cr by the reaction of Cr_3C_2 with Cr_2O_3 is already observed at 1200°C. A rise in temperature leads to an increase in the yield of pure Cr, reaching 96% in the vicinity of the melting point of Cr. It is concluded that the difference in the nature of the reactions of group IV, V, and VI transition metal oxides with carbides is due to the difference in the electronic structure of the metal atoms forming these oxides and carbides. (ATD)

11314 SOME PHYSICAL PROPERTIES OF THE W–LaB_6 ALLOYS. Samsonov, G. V.; Lapshov, Yu. K.; Podchernyaeva, I. A.; Fomenko, V. S.; Erosov, Yu. I.; Dudnik, E. M. (Inst. of Material Science Problems, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 1454-9(Aug. 1966). (In Russian).

The phase composition of several W–LaB_6 alloys (1 to 50 mole % LaB_6) was studied by x-ray technique. Microhardness, specific electrical resistivity from 293 to 1273°K, and thermal emission parameters and emanation coefficients from 1200 to 1950°K were determined for various W–LaB_6 alloys. The alloy samples were prepared by hot pressing of suitable W + LaB_6 mixture in an Ar atmosphere. The x-ray analyses were made with a URS-501M apparatus provided with CuKα-emission source. It was found that during the interaction between W and LaB_6 there occurs a simultaneous formation of two borides, W_2B and WB, and a decomposition of LaB_6. These processes were accompanied by an increase in the specific electrical resistivity of the samples. It was also found that an addition of as little as 1 mole % LaB_6 to W results in a sharp decline in the samples work function. This effect is explained in terms of the declining statistical weight of the stable d^5 configurations in the tungsten atoms leading, in turn, to an easy thermal excitation of the metals nonlocalized electrons. (ATD)

11315 PHASE DIAGRAM OF THE $Sm_2O_3-Cr_2O_3$ SYSTEM. Pavlikov, V. N.; Lopato, L. M.; Yaremenko, Z. A.; Shevchenko, A. V. (Inst. of Materials Science Problems, Academy of Sciences, Ukrainian SSR). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 1055-7(June 1966). (In Russian).

The $Sm_2O_3-Cr_2O_3$ phase diagram was studied in the range from 1600°C to the liquidus temperatures. Petrographic, x-ray diffraction, and chemical data on samples subjected to thermal treatment in argon at 1600 to 2400°C were used to plot the phase diagram. Only one compound, $SmCrO_3$, is formed in the system. It melts congruently at 2300 ± 30°C. It forms eutectics with Sm_2O_3 of the composition 80 mole % Sm_2O_3 and 20 mole % Cr_2O_3 (melting point of 1980 ± 30°C), and with Cr_2O_3 of the composition 16 mole % Sm_2O_3 and 84 mole % Cr_2O_3 (melting point 2080 ± 30°C). No solid solutions could be detected in the system. (ATD)

11316 STATUS OF RESEARCH ON THE SYSTEMS $La_2O_3-ZrO_2$, $Ce_2O_3-ZrO_2$, AND $Nd_2O_3-ZrO_2$. Leonov, A. I.; Keler, E. K.; Andreeva, A. B. (Grebenshchikov Inst. of Silicate Chemistry, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 1047-54(June 1966). (In Russian).

Phase relationships in the systems $La_2O_3-ZrO_2$, $Ce_2O_3-ZrO_2$, and $Nd_2O_3-ZrO_2$ are discussed on the basis of phase diagrams and x-ray and chemical data reported in the literature. A study of the stability and oxidation resistance of the compounds $Ce_2Zr_2O_7$, $Ce_2Ti_3O_{8.4}$, $Ce_2Si_2O_7$, $CeCrO_3$, and $CeAlO_3$ at high temperatures showed that $Ce_2Zr_2O_7$ is the least stable compound. Literature data on phase relationships in ceramic systems of the type $Ln_2O_3-ZrO_2$ indicate that the current methods of studying oxide ceramics (x-ray diffraction, microscopy, chemical phase analysis) are inadequate because they yield averaged characteristics of the structure and composition of matter. Future development of studies of Zr refractories should involve the study of the actual structure and composition in microvolumes by methods of microautoradiography and x-ray spectroscopy. (ATD)

11317 STRUCTURE OF CUBIC TUNGSTEN NITRIDE. Guenther, F.; Schneider, H. G. (Higher Technical School for

Chemistry, Leun-Merzeburg, Ger. Higher Technical School, Ilmenau, Ger.). Soviet Phys.-Cryst. (Engl. Transl.), 11: 585-7 (Jan.-Feb. 1967).

Translated from Kristallografiya, 11: 683-6(July-Aug. 1966).

A structure for $\gamma'-W_3N_4$ is proposed. Three W atoms form a cubic basic lattice of the F type, in which the vertices 000 are vacant, i.e., the W atoms are located at $\frac{1}{2}\frac{1}{2}0$, $\frac{1}{2}0\frac{1}{2}$, and $0\frac{1}{2}\frac{1}{2}$, and the four N atoms are located at $\frac{1}{2}00$, $0\frac{1}{2}0$, $00\frac{1}{2}$, and $\frac{1}{2}\frac{1}{2}\frac{1}{2}$. Analogs to the structure among other nitrides and oxynitrides are discussed. (D.L.C.)

11318 FORMATION OF COMPOUNDS Zr_6O AND Zr_3O IN THE ZIRCONIUM–OXYGEN SYSTEM. Kornilov, I. I.; Glazova, V. V.; Kenina, E. M. (Baikov Inst. of Metallurgy, USSR). Dokl. Akad. Nauk SSSR, 169: 343-6(July 11, 1966). (In Russian).

$Zr-O_2$ systems containing from 1 to 28 at. % oxygen were studied by physicochemical analysis, microscopic analysis, and measurements of microhardness, electrical resistance, and thermal emf. Systems quenched after annealing for 400 hr at 600°C and containing up to 8% O_2 correspond to homogeneous α solid solutions. Above 8% O_2, glide lines typical of decomposition of solid solutions appear. Systems containing 15 to 16% O_2 consist of a single phase, and those with 25 to 26% O_2 show a fine-grained single-phase structure characteristic of a compound. Systems with 28% O_2 have a two-phase structure. Resistivity-composition curves for systems quenched from 600 and 800°C show two singular resistivity maxima at 14.5 and 25% O_2, corresponding to the stoichiometric composition of the compounds Zr_6O and Zr_3O, respectively. A study of the temperature dependence of the electrical conductivity of these compounds, which increased with temperature, confirmed their semiconducting nature. The bonding in Zr_6O is primarily covalent (with a certain fraction of ionic character). (ATD)

11319 EFFECTS OF THE CARBON CONTENT ON THE PROPERTIES OF WC–TiC–Co ALLOYS. Suzuki, Hisashi; Hayashi, Kozi (Tokyo Univ.). Trans. Jap. Inst. Metals, 7: 199-203(July 1966).

WC–TiC–10% Co alloys that contain 6 to 25% TiC in carbides and consist of three phases (WC + β + γ) were vacuum-sintered. The C contents of the specimens were strictly controlled. The relation between the properties of the sintered alloys and the C content or the TiC content was examined. The lattice parameters of the γ and β phases showed a regular change in the three-phase region due to the change in composition in both phases. The W content in the binder phase of the three phase alloys varied from 2 to 3% in minimum to 9 to 10% in maximum depending on the C content. The amount of W dissolved in the binder phase corresponded to the values in the WC–Co alloys. Addition of TiC resulted in an extreme extension of the three phase range owing to the change in C content in the β phase. The properties, such as transverse-rupture strength, magnetic saturation, etc., varied regularly within the three-phase region. (auth)

11320 UNIT CELL DIMENSIONS MEASUREMENT OF LESS PERFECTLY CRYSTALLIZED ARTIFICIAL GRAPHITE. Popovic, S. (Ruder Boskovic Inst., Zagreb). Croat. Chem. Acta, 38: 225-7(1966).

X-ray photographs of artificial graphite were taken using a microfocus x-ray tube and the "Hilger and Watts" Y 103 camera, for which the temperature stabilization was realized. The systematic errors due to absorption, horizontal and vertical beam divergence, eccentricity, and film shrinkage were eliminated by the appropriate procedures. In order to record the low intensity lines the solid specimens without a standard were also used, and the errors due to absorption and horizontal beam divergence were eliminated by the extrapolation to the diameter of the specimen equal to zero. The values of the unit cell dimensions a and c, deduced using the lines (110) and (004), were different from the values deduced using the lines (101) and (112). These results are in agreement with previous findings for the highly crystallized graphites. (auth)

11321 CRYSTALLITE SIZE AND LATTICE DISTORTION DETERMINATION OF GRAPHITE. Popovic, S. (Ruder Boskovic Inst., Zagreb). Croat. Chem. Acta, 38: 229-34(1966).

Profiles of x-ray diffraction lines of graphite were recorded using a diffractometer fitted with a scintillation counter and a single-channel pulse height analyzer. The correction for the instrumental broadening was done both by Stokes' method and by Alexander's procedure using closely located lines of high purity germanium powder and very regular crystal lattice. The crystallite size and the lattice distortion were evaluated by the method of Warren and Averbach. It was confirmed that this method is more adequate than other procedures which include analytical functions for describing the line profiles. In order to minimize the background and to record the low intensity (101), (112), and (114) lines, graphite samples without a standard substance were used. The correction of the profile for absorption was done by extrapolation to the thickness of the specimen equal to zero. The pure diffraction breadths of the corrected profiles were used for determining the proportion of disoriented layers. (auth)

Radiation Effects

Refer also to abstracts 10368, 10369, 11189, 11261, 11277, 11703, and 12150.

11322 (EURAEC–1763) STUDY OF THE SHAPING AND IRRADIATION OF URANIUM CARBIDE. Quarterly Report No. 19, January 1–March 31, 1966. Devillard, J.; Morlot, G. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 32p. (EUR–3318). Dep. mn. CFSTI $3,00 cy, $0,65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The facility designed for irradiation of 8% enriched uranium carbide at 1000°C required alteration to eliminate the strong convection phenomena, which brought irradiation SII 2 to a premature halt. Technical specifications for the facility for the nonisothermal irradiation of uranium carbide are defined. Such irradiation will make it possible to irradiate fuel pins with a conductivity integral close to 100 W/cm. (auth)

11323 (GA–7332) IRRADIATION TESTS OF PYROLYTIC-CARBON-COATED ThC_2 AND ThO_2 PARTICLES. Luby, C. S.; Schwartz, A. S. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Oct. 8, 1966. Contract AT(04-3)-167. 24p. (CONF-660524–26). Dep. mn. CFSTI $3,00 cy, $0.65 mn.

From 2nd International Thorium Fuel Cycle Symposium, Gatlinburg, Tenn.

Results of several irradiation tests to evaluate the stability of pyrolytic-carbon-coated ThC_2 and ThO_2 particles are presented. The coating used was a two-layer pyrolytic-carbon structure called the BISO. It consists of an inner buffer (porous) layer and an outer, dense, isotropic layer. The buffer layer serves to relieve stresses in the outer coating that might arise from radioinduced dimensional changes in both the fuel and the pyrolytic C, and also acts as a fission-recoil-attenuating layer. The outer coating is considered to be the actual "pressure vessel." Thin coatings are desired in order to obtain high metal loadings in the coated particles. A series of irradiation tests was conducted to evaluate these particles at temperatures up to 1875°C, fuel burnups up to 3% FIMA (due to fissioning of ^{233}U formed from the ^{232}Th), and fast-neutron-flux exposures up to 2.7×10^{21} (E > 0.18 MeV). Some of the particles used in these tests contained small amounts of U so that desired fuel burnups could be attained in reasonable times. The results of these tests showed that either ThC_2 or ThO_2 is satisfactory for use with two-layer BISO pyrolytic-C coatings. Coated particles with adequate metal contents were found to have good stability and fission-product retention at irradiation temperatures up to 1400°C (above the maximum fuel temperature anticipated in an HTGR core); at irradiation temperatures of 1875°C some coating failures occurred. These results also indicated that coatings 100 to 130 μ thick will provide the desired stability for particles 300 to 400 μ in diameter. Current efforts are directed toward optimization of coating structural parameters and evaluation of the coated particles under higher irradiation exposures. (auth)

11324 (STI-DOC–10/59) THERMAL CONDUCTIVITY OF URANIUM DIOXIDE. Report of the Panel held in Vienna, 26–30 April 1965. Technical Reports Series No. 59. (International Atomic Energy Agency, Vienna (Austria)). July 1966. 72p. IAEA: $2,00; S 42,-; 12/-stg; F Fr 8,-; DM 6,40.

The thermal conductivity of UO_2 was evaluated and the effects of temperature, stoichiometry, state of aggregation, and irradiation considered. Attention was also paid to the mechanisms of heat conduction. (M.C.G.)

11325 SCATTERING AND ABSORPTION OF LIGHT BY NEUTRON-IRRADIATED QUARTZ. Mitchell, E. W. J.; Whitehouse, J. E. (Univ. of Reading, Eng.). J. Phys. Chem. Solids, 28: 1-10(Jan. 1967).

Measurements have been made of the relative intensity of light emerging from quartz crystals at right angles to an incident beam, including the effect of an irradiation of 6.4×10^{18} fast neutrons cm^{-2} on one crystal. The emergent light comprises both luminescence emission and light scattered from the incident beam. After irradiation the former predominates, and the measurements therefore give the excitation spectrum for the process. By comparing the spectra measured in this way with transmission absorption spectra, and also by studying the changes in these spectra during optical and thermal bleaching, it was shown that a weak lumi-

nescence is associated with absorption in the A_1 and A_2 bands. The different rates of bleaching of the A_1 and A_2 bands show that they do not both arise from the Al center as originally suggested in the O'Brien–Pryce model. It is possible to account for one of the bands (A_2) using this model if it is assumed that the lower levels lie within the valence band. In this way the width of A_2 is also explained. After heating to 540°C, which completely removes the absorption in the A_1 and A_2 bands, the scattered light is observed. The amount of scattering by the irradiated sample is in excess of that for the unirradiated sample. The excess is interpreted as mainly scattering by radiation-induced imperfections. Its magnitude can be explained by the presence of a reasonable number of point defects either separated or in small clusters. The results are not consistent with the presence of grossly disordered regions in numbers which might be expected on other grounds. (auth)

11326 STEPWISE RELEASE OF FISSION GAS FROM UO_2 FUEL. Notley, M. J. F.; MacEwan, J. R. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Appl., 2: 477-80(Dec. 1966).

Measurements of the fission-product gas pressure in UO_2 fuel elements during irradiation showed that a significant amount of gas is released during power transients. The gas appears to be released as the element power is decreased to zero during reactor shutdown; little release occurs as the power is raised at startup. It is postulated that gas trapped in bubbles or in central voids is released by cracking or stress-induced movement during power transients. (auth)

11327 IRRADIATION DAMAGE TO SINTERED BERYLLIUM OXIDE AS A FUNCTION OF FAST-NEUTRON DOSE AND FLUX AT 110, 650, AND 1100 DEG C. Keilholtz, G. W.; Lee, J. E. Jr.; Moore, R. E. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 26: 329-38(Nov. 1966).

An irradiation program to evaluate BeO as a moderator or fuel matrix material in nuclear power reactors has been completed. The primary objectives were to establish the limits of stability of sintered BeO of various grain sizes and densities toward fast neutrons and to determine mechanisms of damage. Specimens were irradiated at 110, 650, and 1100°C; fast neutron doses up to 4.7×10^{21} n/cm^2 (>1 MeV) were achieved. Both long-term and short-term irradiations were carried out in the same flux profile to determine the effect, if any, of flux intensity or dose rate on neutron damage. Specimen fracturing, volume expansion, and lattice parameter expansion all increased with increasing neutron dose and decreased with increasing temperature. However, even at the maximum temperature, some specimens disintegrated completely to powder when irradiated to doses greater than 2×10^{21} n/cm^2 (>1 MeV). The principal mode of damage under all conditions was grain boundary separation, which was caused by anisotropic crystal expansion resulting from fast neutron produced defects. No flux intensity effect on gross damage was detected in any of the experiments. Volume expansion, a reliable criterion of neutron damage to BeO, was found to be greater in long-term than in short-term irradiations at 1100°C at equivalent neutron doses. In-pile annealing of neutron damage at this temperature may be expected to produce a flux intensity effect on damage, but it is masked by another effect that is a function of the number of thermal cycles incurred during reactor operation. Thermal cycling appears to promote the separation of grain boundaries stressed by anistropic crystal expansion, thereby increasing the volume expansion. To minimize neutron damage in reactor application, BeO of small grain size and low density should be used at as high a temperature and with as few thermal cycles as practicable. (auth)

Plastics and Other Materials

Refer also to abstracts 10306, 10377, 10399, 11239, and 11693.

11328 THERMAL NEUTRON IRRADIATION OF COTTON. Blouin, Florine A.; Arthur, Jett C. Jr.; Orr, Rollin, S.; Ott, Vega J. (Southern Regional Research Lab. New Orleans). Textile Res. J.; 31: 597-602(July 1961).

Purified cotton samples were irradiated with thermal neutrons in dose ranges from 5×10^{14} to 1×10^{17} n/cm^2. Neutron irradiation produced chain cleavage, carboxyl groups, and reducing groups in the cotton cellulose. Water solubility of the cotton was not appreciably affected in this dose range. Wet and dry strengths and elongation of the cotton were decreased by neutron irradiation. Uniformity of strength along the fiber length was only slightly lowered. The reducing groups produced in the neutron-irradiated cotton were shown to be markedly different in degree of reaction with sodium chlorite, copper equivalence, and influence on alkali sensitivity from the reducing aldehyde groups produced by periodate oxidation of cotton cellulose. A close similarity between the effects of thermal neutron and γ-ray irradiation of cotton was observed; both types of irradiation produced an oxidative degradation. Some marked differences between irradiated cottons and periodate-oxidized cottons were observed. A large difference in copper equivalence between the aldehyde groups in the irradiated cottons and those in the periodate-oxidized cotton that were converted to acids by chlorite was noted. This indicated that the aldehydes in the irradiated cottons were probably not of the C_2 and C_3 type present in periodate-oxidized cottons. The high copper equivalence obtained with the irradiated cottons suggested that at least some of the aldehyde groups present in the irradiated cotton were similar to those present in dichromate-oxalic acid oxidized cellulose. (BBB)

11329 RESULTS OF RESEARCH ON POLYPROPYLENE FIBERS. Geleji, Frigyes. Magyar Kem. Lapja, 21: 571-8(Nov. 1966). (In Hungarian).

Research in polypropylene fiber manufacture is surveyed. The choice of the polymer suitable for, and the questions arising in the technology of fiber formation are discussed. Results in stabilization against thermal and radiation damage, and attempts at an enhancement of dyeing effects, are discussed with application for the textile industry. (auth)

11330 PHOTOLUMINESCENCE OF IRRADIATED PLASTICS. Dezsi, Z. (Medical Univ., Debrecen, Hungary); Patko, J.; Szentirmay, Zs. Nature, 212: 751(Nov. 12, 1966).

The applicability of various types of polymethyl methacrylate (PMMA) to radiation dosimetry was investigated. It was found that besides the discoloration induced by radiation, the irradiated PMMA exhibits photoluminescence. Several types of PMMA were investigated with an analytical mercury lamp. (W.D.M.)

PHYSICS (GENERAL)

Astrophysics

Refer also to abstracts 11487, 11725, 12007, 12011, 12027, 12074, 12098, and 12113.

11331 (JILA–88) RECENT WORK ON STELLAR INTERIORS: A BIBLIOGRAPHY OF MATERIAL PUBLISHED BETWEEN 1958 AND MID-1966. Langer, Edward; Herz, Margaret; Cox, J. P. (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Dec. 9, 1966. Contract DA31-124-ARO-D-139. 120p. (AROD–4445:65).

This bibliography of recently published material on stellar interiors and closely related subjects was compiled for the time period of 1958 to mid-1966. A review article on stellar evolution by Burbidge and Burbidge (Handbüch der Physik) contains a comprehensive bibliography on the relevant literature published before 1958. The articles are listed alphabetically by author (by the first author in cases of multiple authorship, and by date in cases of several articles by the same author) in several different categories. (W.D.M.)

11332 (N–66-19199) OBSERVATIONS WITH UNIVERSITY OF IOWA EQUIPMENT ON MARINER IV, MAY–OCTOBER 1965. Preliminary Report. Krimigis, S. M.; Van Allen, J. A.; Frank, L. A. (State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy). Oct. 25, 1965. Contracts NAS7-100; JPL-950613. 25p. (NASA-CR–70379). CFSTI $3.00 cy, $0.65 mn.

For Jet Propulsion Lab., Pasadena, Calif.

Measurements of solar electron and proton events made with the trapped radiation detector on Mariner IV are presented. Results from interplanetary space obtained from the beginning of May to October 1, 1965, the date on which transmission of data was terminated, are given. Counting rate plots of the events observed during the period are shown; and a tabulation of solar proton and electron events observed during November 28, 1964 to October 1, 1965, is given listing the heliocentric radial distance of the spacecraft; the earth-sun-probe angle; the maximum particle flux; type of event; and class of flare activity as seen from the earth. (STAR)

11333 (N–66-21096) ADAPTION OF EVOLUTIONARY PROGRAMMING TO THE PREDICTION OF SOLAR FLARES. Fogel, Lawrence J.; Owens, Alvin J.; Walsh, Michael J. (General Dynamics/Convair, San Diego, Calif.). Apr. 1966. Contract NAS5-3907. 110p. (NASA-CR–417). CFSTI $3.00 cy, $0.65 mn.

Application of an evolutionary programming technique to the prediction of solar flares is discussed. Evolutionary programming was originally devised as an alternative means for addressing some fundamental problems of artificial intelligence. In contrast to the bionic approach and heuristic programming, evolutionary programming does not attempt to replicate human performance, either biological or psychological. Instead, attention is focused upon the logic of Darwinian evolution as a means for generating a suitable logic for overcoming a wide variety of problems, as witness the survival of living organisms. The advent of high speed digital computers makes such replication practicable. Evolutionary programming was first restricted to problems of predicting binary environments. Demonstration of a considerable level of success in predicting certain difficult environments, such as the primeness of each successive positive integer, justified offering evolutionary programming as means for the prediction and analysis of real-world time series. The program and the fundamental concepts involved are described in detail. (STAR)

11334 (N–66-38758) SOLAR FLARE HAZARD TO EARTH-ORBITING VEHICLES. Final Report. (Republic Aviation Corp., Farmingdale, N. Y.). Apr. 11, 1966. Contract NAS1-3601. 50p. (NASA-CR–66202). CFSTI $3.00 cy, $0.65 mn.

The object of this study was to calculate the primary radiation incident on earth-orbiting vehicles during a solar flare. The effects of the earth's geomagnetic field were taken into account, as well as those of a perturbing field due to the geomagnetic storm associated with a solar flare. Simple earth shadow effects were also taken into account. Using this primary radiation as source function, dose rates for given orbits are then calculated using a computer routine. Dose rates are computed for typical orbits within a typical vehicle for the solar flares of February 23, 1956 and November 12, 1960. (auth)

11335 (NP–16433) RADIACION NO TERMICA DEL SOL. (Non-thermal Solar Radiation). Arriola Santamaria, Humberto (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ciencias). 1965. 53p. (In Spanish). Dep. mn.

Thesis.

The processes for the production of energy within the sun are analyzed and the energy transport mechanism leading to the production of solar flares is reviewed. The various types of radio-frequency explosions taking place in the sun are described. A mechanism for the production of flares from the annihilation of the magnetic field is analyzed. (J.S.R.)

11336 (UCRL–14509) DYNAMICAL EVOLUTION OF SPHERICAL GALAXIES. Campbell, Philip M. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 20, 1965. Contract W-7405-eng-48. 11p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Numerical calculations of galactic evolution indicate that the observed structure of elliptical galaxies is uniquely determined by the conditions at the time of star formation. An isothermal initial state results in a final state consistent with observation under the assumption of a constant mass/light ratio throughout the galaxy. The protogalaxy of an average giant elliptical is found to have the following properties: mass, 8×10^{44} g; radius, 4×10^{22} cm; average density, 3×10^{-24} g/cm^3; temperature 5×10^6°K. (auth)

11337 (UCRL–14527-T) DYNAMICS OF SPHERICAL GALAXIES. [PART] II. Campbell, Philip M. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 28, 1965. Contract W-7405-eng-48. 15p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Some results are presented from a study of galactic structure. Numerical calculations of dynamical evolution are used in conjunction with theories of star formation to obtain final equilibrium states consistent with observation. The calculations are restricted to collisionless, self-gravitating systems with spherical symmetry. A preliminary investigation, based on a model with nearly radial orbits, has already appeared in proceedings of the National Academy of Sciences, 48: 1993 (1962). (W.W.M.)

11338 (NASA-TT–F-342) PHYSICS OF THE SOLAR SYSTEM. Volume 3 of A Course in Astrophysics and Stellar Astronomy. Vyazanitsyn, V. P.; Gnevyshev, M. N.; Dobrovolskii, O. V.; Krat, V. A.; Markov, A. V.; Molchanov, A. P.; Sobolev, V. M.; Sharonov, V. V. Translation of Kurs Astrofiziki i Zvezdnoi Astronomii, Izdatel'stvo Nauka, Moscow, 1964. 398p. (TT–66-51022; IPST-Cat.–1526). CFSTI $3.00 cy, $0.65 mn.

Observational results of the sun and the planetary system are considered. The principal theoretical studies related to interpretation of the observational data are given only briefly. Topics covered include the solar line spectrum, structure of the photosphere (granulation, sunspots, and faculae), the chromosphere, prominences, chromospheric flares, the solar corona, the solar survey, solar radio emission, the moon, physics of the planets, description of individual planets, physical properties of the minor planets, comets, meteors, and the zodiacal light. (W.D.M.)

11339 FITTING OF RADIATIVE LAYERS TO CONVECTIVE ONES IN STELLAR ATMOSPHERES. Sack, Noam (Hebrew Univ., Jerusalem). Ann. Astrophys., 29: 633-7(Nov.-Dec. 1966).

A method of fitting the radiative layers of a stellar atmosphere, to its convective ones is presented. It is found that in order to perform this fit it is necessary to take into account the fact that those two kinds of layers are treated by different methods of approximation. Numerical results are given. (auth)

11340 ORIGIN OF THE SOLAR SYSTEM. McCrea, W. H. (Univ. of Sussex, Falmer, Eng.). Proc. Roy. Inst. Great Brit., 40: Pt. 3, No. 184, 236-55(1964).

Several concepts of the genesis of stars and the origin of the solar system are discussed. In regions where cold interstellar material is surrounded by hot interstellar material, and the hot material would tend to compress the cold, under these conditions, it is estimated that a mass of between 100 and 1000 solar masses can thus be brought to contract. This is about a typical mass of an interstellar cloud. This is thought to be the first stage in forming a stellar cluster. How such a mass breaks up into parts to form a few hundred stars is explained in terms of spin-momentum. The matter inside the region destined to form a star must have some spin-momentum about its mass-center; if the overall effect is simply to compress the material, then this spin-momentum is conserved. This means that as the portion contracts the actual speed of rotation goes up as the dia. decreases. Using likely figures for the initial state, it is calculated that a sun having a peripheral speed of about 300 times the speed of light could result. This result means that if the sun was formed in this way, almost all of its initial spin-momentum must have been extracted from the material. This aspect of the angular momentum difficulty is an obstacle to this view of star-formation. Another possibility, that of electromagnetic action is discussed. It is believed that

there is a magnetic field pervading the interstellar medium; also, in general, interstellar matter would be a good electrical conductor. So the requirements for magnetic braking, appear to exist. In the theory in which magnetic braking plays a vital part, the formation of the sun is considered to start with the gravitational contraction of a portion of interstellar matter as described. In the early stages much of the angular momentum would be lost to the surrounding cloud by magnetic braking. The angular momentum that was left was that estimated for the present solar system plus that of light elements lost from the planetary matter. Then the portion of matter became magnetically isolated and proceeded to contract further, now without loss of angular momentum. When it formed a body filling about the present orbit of Mercury, it became rotationally unstable, so it began to shed material from an equatorial rim. The discarded matter remained magnetically linked with the main body, with the result that angular momentum passed from the main body to the discarded matter. This allows the main body to go on contracting. But because of the gain of spin-momentum by the discarded matter, this spreads further out. This goes on until very little spin-momentum is left in the main body, which ultimately forms the sun. Most of the spin-momentum gets into the disk of matter, or solar nebula, which at this stage is spread out in the equatorial plane. (BBB)

11341 NONRADIAL OSCILLATIONS AND CONVECTION IN STARS. **Smeyers, P. (Univ., Liege). Ann. Astrophys., 29: 539-48(Nov.-Dec. 1966). (In French).**

The two types of gravitational modes (one stable, the other unstable) which occur among the normal modes of a gaseous sphere in hydrostatic equilibrium when it contains both sub- and superadiabatic regions are studied in the case of a sequence of formal models comprising a convectively unstable homogeneous core and a convectively stable polytropic envelope. (auth)

11342 TIDES IN CLOSE BINARY STARS. **Zahn, Jean-Paul (Institut d'Astrophysique, Paris). Ann. Astrophys., 29: 565-76 (Nov.-Dec. 1966). (In French).**

The principle properties of tides in a close binary system are outlined and their effects on the dynamic and nuclear evolution of the system are examined. The major results concerning the rupture of radiative equilibrium by a harmonic external potential are collected. The radiative tide in the simple case of spherical rotation is studied. The role played by the tides, resonance apart, in the evolution of close binaries is considered. The theory predicts rapid circularization of the orbits of systems containing at least one star with an external convective zone, and this is born out by observation. Moreover, the outer region of Cowling type stars is the seat of Rayleigh instability which shows up as superficial turbulence. Finally, under certain conditions components of this type may undergo homogeneous evolution of semi-detached systems of the Algol type. (auth)

11343 LITHIUM ABUNDANCES IN F, G, AND K-TYPE SUBGIANTS. **Herbig, G. H.; Wolff, R. J. (Univ. of California, Mount Hamilton). Ann. Astrophys., 29: 593-600(Nov.-Dec. 1966).**

The present status of the interpretation of Li abundances in main-sequence stars is discussed. The Li abundances obtained in 12 (evolved) stars of types F6–K1 IV are then interpreted from this point of view. For those subgiants with masses of 1.2 to 1.4 solar masses the Li contents are probably the original main-sequence values, but reduced by increasing amounts of convective dilution for B-V values greater than +0.75. At masses near 1.0 solar mass, a few subgiants have Li contents about 10 times the solar value. This fact is difficult to explain if at those masses there is slow convective depletion of Li on the main sequence. Some possible means of evading this difficulty are considered, such as Feast's suggestion of a re-synthesis of new Li, and the effect of mass loss while the star is still on the main sequence. (auth)

11344 QUANTITATIVE METHOD OF THREE-DIMENSIONAL CLASSIFICATION OF COLD STARS. APPLICATIONS. **Spite, Francois (Observatoire de Paris-Meudon). Ann. Astrophys., 29: 601-31(Nov.-Dec. 1966). (In French).**

Central depths of a score of strong lines were measured for some hundred stars, on moderate dispersion spectrograms. These measurements are essentially a function of effective temperature T_{eff}, gravity g, and metal abundance F, not of microturbulence. Since the number of stars with known gravity is not sufficient, the gravity g will be replaced by the absolute magnitude M_V. From stars studied in the literature, it is found empirically that simple combinations of the measured depths are in good correlation with the parameters T_{eff}, M_V, and F. More general methods can then be used, and a systematical search can be made of the optimal combinations of the most significative lines. After setting, in such a manner, as narrow correlations as possible between measurements, combinations and stellar atmosphere parameters, it is possible to determine, in turn, these parameters by interpolation, for stars not yet studied, from measurements of line depths. In addition to T_{eff}, M_V, and F (or [Fe/H]), it is still possible to determine the color index B-V independently of the interstellar reddening. The determinations of these four quantities is, at most only twice less precise than the corresponding determinations from high dispersion spectra. Applied to some hundred stars, this method enables the study of some star groups: ROMAN'S wk-l and st-l stars, photometric "subdwarfs," old stars, complete sample of cold stars near the sun. Among the results, one can point out that ROMAN'S wk-l and st-l stars cannot be distinguished neither by abundance nor by luminosity and that the distribution of abundances for the stars near the sun is analogous to the distributions, found by others, from the color index (which can be altered by microturbulence) and from samples selected in a less systematic way. (auth)

11345 RADIOASTRONOMY IN THE USSR. **Panovkin, Boris. Telecommun. J., 33: 388-92(Nov. 15, 1966).**

Techniques, instrumentation, and results of radioastronomy studies conducted in the USSR are reviewed. Radioastronomical observations are being made at the Central Astronomical Observatory at Pulkovo, the Lebedev Physics which has a large astronomical center near Serpukhov, the Gorki Institute of Radiophysical Research, the Pavel Sternberg Institute of Astronomy, and the Radiophysics and Electronics Institute of the Academy of Sciences of the Ukraine. Studies in galactic and metagalactic radioastronomy have led to a theory of the origin of radiation in space. It has been suggested that a synchrotron mechanism, i.e., the braking radiation of rapid relativistic electrons in interstellar magnetic fields, is the source of the space radiation background. It has been shown that the relativistic electrons in the galactic stellar fields constitute the electronic component of primary space radiations. It has also been shown that cosmic rays are much less concentrated in metagalactic space than in the Galaxy. A theory of the origin of the Crab nebula radiation spectrum has been elaborated which explains this radiation by the synchrotron mechanism. New high-power radiotelescopes are being designed and constructed in the USSR, some of which are described and illustrated. A large T-shaped radiotelescope is being completed at the Kharkov Radiophysics and Electronics Institute; it will be used to scan the HF bands from 12.5 to 30 m. Armenian scientists are working on a new type of radiotelescope, the large 2-mirror antenna. Unlike existing antenna arrays which have one mobile mirror, the main reflector of this radiotelescope (100 m in dia) is fixed. The second mirror, which has a dia of 8 m and is above the large one, will be movable. It will collect the radio waves from the reflector and direct them to the receiver. The special shape of the small mirror will completely eliminate the aberrations normally found in spherical mirrors. (BBB)

11346 MAGNETIC FIELDS AND ACTIVE REGIONS ON THE SUN. **Severny, A. Scientia (Milan), 60: 395-405(1966).**

This review deals with various properties of solar magnetic fields concentrated in active regions, responsible for different kinds of solar activity such as solar flares and other violent phenomena. Two aspects are considered in particular: the gross aspect considering the averaged field as a whole which leads to dipole-like representation of observational properties of the magnetic field, the aspect of structural unhomogeneity leading to strongly pronounced effects of fine structure of the magnetic field such as twisting of lines of force, rotations, and other unhomogeneities displaying themselves on a small scale compared to the size of sunspot. (W.D.M.)

11347 EQUIVALENT WIDTHS AND THE ABUNDANCE OF STRONTIUM IN THE SUN. **Grevesse, N. (Institut d'Astrophysique, Cointe-Sclessin, Belg.). Ann. Astrophys., 29: 289-91 (May-June 1966). (In French).**

Equivalent widths of the lines at 4607.338 of Sr I and 4161.8 of Sr II were measured on tracings of the solar spectrum obtained at the Jungfrauhoch, Switzerland. The width of the former is found to be 50.3 mÅ, which is greater than that reported by other authors since 1934. Similarly, the width of the latter is found to be 32 mÅ, again greater than previous estimates (earlier values for the two figures are 43 and 27, Allen, 1934; 40.2 and 23.8, Claas, 1951; 36 and 30, Utrecht, 1951; 41 and 22, Goldberg, Mueller, and Aller, 1960.). For the first line, log gf = 0.26, log (N_{Sr}/N_H) = 2.72; for the second, log gf = –0.45, log (N_{Sr}/N_H) = 3.00. Less emphasis is placed on the latter figure because the width is not known so precisely, and because the theoretical curve of Fe I is less applicable to Sr II than to Sr I. (BBB)

11348 BRIGHTNESS OF THE CORONA IN THE VICINITY OF SOLAR PROTUBERANCES. **Leroy, J. L.; Servajean, R. (Observatoire de Meudon, France). Ann. Astrophys., 29: 263-9(May-June 1966). (In French).**

By selection of the 3 colors from color pictures of the sun obtained during the eclipse of May 30, 1966, it was possible to separate the images of the corona from those of prominences. No appreciable variation larger than 5% of the brightness of the corona could be observed in the immediate neighborhood (3000 km) of the prominences. A Kodachrome IIA film was used, preceded by 2 green filters (Wratten type 102). Under similar conditions a microphotometric study of images of the corona was unable to give evidence of a modification of any sort of brightness in the vicinity of prominences. (BBB)

11349 RESEARCH PROBLEMS IN SPECTROSCOPY OF HIGHLY IONIZED ATOMS AS A RESULT OF OBSERVATIONS BY SPACE RESEARCH. Fraenkel, Benjamin S. (Hebrew Univ., Jerusalem). Israel J. Technol., 4: 106-9(1966).

Suggestions are made for research in both rocket and lab spectroscopy, to clarify problems which arise through observations in the far-uv spectrum of the solar corona. Feasibility of spectroscopy of stellar coronae is also discussed. Strong transitions between excited states of highly ionized atoms should be looked for in the visible, near-uv, and normal incidence far-uv wavelength ranges. Once such transitions are known, the solar corona would be open for spectroscopic investigation of (possible) "allowed transitions" from the surface of the earth. Classification of such lines in the far-uv range of normal incidence, up to 2000 Å, would be of special importance for stellar coronae, where grazing incidence space spectroscopy would be difficult. The evidence leading to the classification of some of the forbidden coronal lines is often based on unrealistic extrapolations. It would be of interest to excite such transitions in the lab and confirm their classifications. This does not seem impossible, by using large tandem accelerators. When the spectrometer is adjusted to look at regions well beyond the target, such transitions should be seen, as the vacuum conditions in the tandem may be adequate for comparison with those in the corona. The problem of the Doppler shift must, however, be overcome in this case. Techniques for spectroscopy of highly ionized atoms should be developed for nonmetals and metals of low mp. These techniques should be sought for low voltage vacuum sparks rather than for plasma discharges. Differentiation techniques are probably advanced enough to cope with the high spectra of the fifth row metals, which are known to be fairly represented by strong lines in the spectra of certain stars. (BBB)

11350 DIRECTION OF GAS TAILS OF COMETS AND THEIR CONNECTION WITH INTERPLANETARY PLASMA AND SOLAR ACTIVITY. Pflug, Klaus (Astrophysical Observatory, German Academy of Sciences, Potsdam). Mem. Soc. Roy. Sci. Liege, 12: 363-8(1966).

Use is made of the relation $\gamma = \mu_t/(v = \mu_r)$ (where γ is the observed angle — corrected for projection effects — between the tail axis and the radius vector and μ_t and μ_r are the tangential and radial components of the orbital motion, respectively) to search for connections between characteristics of comets, interplanetary plasma, and solar activity. The investigation is based on 323 single observations of 11 comets. The results agree satisfactorily with measurements made during the flight of Mariner 2 and with previous studies of comets. (Int. Aerospace Abst.)

11351 THE SOLAR WIND AND THE ORIENTATION OF TYPE I COMET TAILS. Brandt, John C. (Kitt Peak National Observatory, Tucson, Ariz.). Mem. Soc. Roy. Sci. Liege, 12: 309-15(1966).

A preliminary discussion is presented of the solar wind and of type-I comet tails. Velocities of the solar wind are considered, and the results of preliminary calculations are tabulated. The plasma velocities determined from type-I comets are found to be similar to the values derived by the Mariner 2 space probe, which seems to establish type-I comets as a statistically reliable and valuable probe of the solar wind velocity. (Int. Aerospace Abstr.)

11352 CHROMOSPHERIC FLARES AND THE PROBLEM OF A STRONG POINT EXPLOSION WITH A CONSIDERATION OF THERMAL CONDUCTIVITY IN SELF-SIMILAR MOTION AND SPHERICAL SYMMETRY. Guseinov, R. E. pp 21-43 of Soobshcheniia Shemakhinskoi Astrofizicheskoi Observatorii. Vypusk 4-Fizika Solntsa. Sultanov, G. F.; Aslanov, I. A.; Eminzade, T. A. (eds.). Baku, Izdatel'stvo Akademii Nauk Azerbaidzhanskoi SSR, 1965. (In Russian).

A discussion is presented of the possibility of using a mathematical device for describing a strong point explosion, with consideration of thermal conductivity, to calculate the nature and effect of chromospheric flares. The explosive nature of chromospheric flares is suggested by the supergravitational accelerations of their matter, sudden appearance and rapid achievement of maximum brightness, and synchronous variation of relative intensity and altitude of the flare above the limb. However, the effects of magnetic fields, plasma and particle reactions, and thermal conductivity must also be considered in calculating flares with this device. (Int. Aerospace Abstr.)

11353 RECENT RESULTS OF QUASAR RESEARCH. Pfleiderer, Joerg; Priester, Wolfgang (Univ., Bonn). Sterne Weltraum, 5: 200-5(Aug.-Sept. 1966). (In German).

Recent results of research concerning the origin of quasars and their radio-emission spectra are reviewed. The radio source Tau A in the Crab Nebula is cited as being of great importance in the study of quasars, since not only its radio emission, but also its optical continuum emission is largely attributable to the synchrotron mechanism. Evidence for the existence of explosive processes in quasars is presented. The most important findings concerning quasars are listed, as well as the conclusions that can be drawn from these findings. In particular, it is concluded that the distribution of currently identified quasars is approximately isotropic, the quasar radio-emission spectrum is to be interpreted as a synchrotron-emission spectrum, the optical continuum of quasars is also to be regarded as synchrotron emission, and all emission lines of quasars are strongly red shifted. (Int. Aerospace Abstr.)

11354 POSSIBLE VARIATION OF THE CORONAL COMPOSITION WITH LATITUDE AND THE POLAR CORONAL TEMPERATURE. Brandt, John C. (Kitt Peak National Observatory, Tucson, Ariz.). Observatory, 86: 138-40(Aug. 1966).

A discussion of the polar corona temperature is given and it is demonstrated that the value of the temperature inferred from density gradients may be significantly influenced by a latitude dependence of the coronal composition. References are cited to show that the helium abundance (and that of other heavy elements) relative to hydrogen must, on the average, be greater near the poles than near the equator. (Int. Aerospace Abstr.)

11355 POSSIBLE MODELS FOR X-RAY SOURCE, SCO-X-1. Matsuoka, M.; Oda, M.; Ogawara, Y. (Tokyo Univ.). Nature, 212: 885-6(Nov. 26, 1966).

The properties of Sco X-1 are listed and it is assumed that it is an astronomical object at a distance of 200 pc and that the continuum from optical radiation to the x-ray region is caused by the thermal radiation of optically thin hot plasmas at temperatures of 5×10^7°K. Possible models for this source are considered by restricting the discussion to conditions under which a hot plasma of this type is compatible with observations. (W.D.M.)

11356 RADIO OBSERVATIONS OF THE QUIET SUN AT 49 cm. Swarup, G.; Kapahi, V. K.; Isloor, J. D.; Sinha, R. P. (Tata Inst. of Fundamental Research, Bombay). Nature, 212: 910-11(Nov. 26, 1966).

The brightness distribution over the quiet Sun has been measured at 50 and 60 cm with aerial interferometers in 1954 and 1955. Both series of observations showed much less limb brightening than was predicted theoretically which was explained by assuming that inhomogeneities in the solar corona scatter radiowaves. Observations made using an interferometer of high resolution located near Bombay were found to be consistent with theoretical distributions based on a smooth corona and indicated that earlier measurements may be unreliable because of insufficient resolution. (W.D.M.)

11357 PRODUCTION OF FAST DRIFT BURSTS. Zirin, H. (California Inst. of Tech., Pasadena. Carnegie Institution of Washington, D. C.). Nature, 212: 909-10(Nov. 26, 1966).

Three kinds of fast drift radio bursts from the sun, with frequency changes corresponding to outward velocities of 10^5 km/sec, are observed: type-III bursts; type-II slow-drift bursts; and "inverted-U bursts." It is proposed that a natural explanation of this common phenomenon of fast-drift bursts is that there is a characteristic velocity in the solar atmosphere with which waves propagate naturally when disturbances occur. This propagation clearly must be the Alfvén wave. Alfvén waves must occur whenever the magnetic field is perturbed, either by a flare or the passage of a shock wave. They propagate easily, with little dissipation. As they travel outward, they should steepen into weak MHD shocks; these in turn excite plasma oscillations which produce the radio emission from each point along the path. (W.D.M.)

11358 LINE WIDTHS IN SPICULES. Livshits, M. A. (Inst. of Terrestrial Magnetism, the Ionosphere, and Radio Wave Propagation, Academy of Sciences, USSR). Soviet Astron. AJ (Engl. Transl.), 10: 570-7(Jan.-Feb. 1967).

Translated from Astron. Zh., 43: 718-26(July-Aug. 1966).

Observations with the coronagraph of the Institute of Terrestrial Magnetism are reported for the H, He, and Ca^+ lines in chromospheric spicules. Chromospheric elements (spicules) of characteristic size ≈2000 km are primarily discussed. The line widths vary strongly from one spicule to another, but do not depend ap-

preciably on height. The lines do not have Doppler profiles. Several alternative explanations for the large spicular line widths are discussed. Strong self-absorption in spicules and high spicule temperatures are rejected. The line widths, and to some extent the profile shapes, imply large-scale motions of ±10 km/sec inside the spicules. Possible interpretations of the motions are suggested briefly—a collection of small condensations in motion, or rotation of the spicule as a whole. (auth)

11359 FORCE-FREE MODEL FOR THE MAGNETIC FIELD OF A SUNSPOT. Molodenskii, M. M. (Inst. of Terrestrial Magnetism, the Ionosphere, and Radio Wave Propagation, Academy of Sciences, USSR). Soviet Astron. AJ (Engl. Transl.), 10: 578-81(Jan.-Feb. 1967).

Translated from Astron. Zh., 43: 727-31(July-Aug. 1966).

Magnetometer observations of the total magnetic-field vector in a spot can yield sufficient data to reconstruct the field in the chromosphere above the spot. A procedure is developed for such a calculation and preliminary computations are made for the field of an axially symmetric spot. (auth)

11360 NATURE OF RADIO SOURCES IN GALAXIES. Kurilchik, V. N. (Shternberg Astronomical Inst., Moscow). Soviet Astron. AJ (Engl. Transl.), 10: 582-7(Jan.-Feb. 1967).

Translated from Astron. Zh., 43: 732-9(July-Aug. 1966).

Arguments are given for a disk radio-brightness distribution in the extended radio sources of spiral galaxies. The relativistic-particle energies and magnetic field strengths in the spiral arms of galaxies are estimated for a disk model. The ratio of the proton and electron cosmic-ray components in galaxies is discussed. Relativistic-particle acceleration during the active phase of galactic nuclei is probably continuous, rather than resulting from comparatively frequent explosions. Continuous acceleration and escape of relativistic particles from nuclear regions is fully adequate to meet the energy requirements of the phenomena in extended galactic disks. The highly excited nuclei of Seyfert galaxies may represent an initial stage in the active processes occurring in galactic nuclei. (auth)

11361 SPECTRA OF THE SUPERNOVA REMNANTS HB 3 AND HB 9 AT DECAMETER WAVELENGTHS. Bazelyan, L. L.; Braude, S. Ya.; Men, A. V. (Inst. of Radiophysics and Electronics, Academy of Sciences, Ukrainian SSR). Soviet Astron. AJ (Engl. Transl.), 10: 588-93(Jan.-Feb. 1967).

Translated from Astron. Zh., 43: 740-6(July-Aug. 1966).

Flux densities and angular sizes for the extended supernova-remnants HB 3 and HB 9 were measured in the frequency range 20 to 40 Mc. Spectra are derived and the angular size of HB 9 is obtained as a function of frequency; the corrected results of other authors' observations are incorporated. The findings are discussed briefly. (auth)

11362 REMARKS ON SUPERNOVA REMNANTS. Shklovskii, I. S. (Shternberg Astronomical Inst., Moscow). Soviet Astron. AJ (Engl. Transl.), 10: 594-8(Jan.-Feb. 1967).

Translated from Astron. Zh., 43: 747-53(July-Aug. 1966).

The extremely hot plasma in some "old" remnants of type II supernova outbursts should emit coronal lines such as λ 5303 [Fe XIV]. Although faint, the emission may be observable. An appreciable soft x-ray flux, up to 10^5 photons·cm^{-2}·sec^{-1}, should appear in the O VIII and O VII lines near λ = 20 A. Younger type II supernova remnants (such as Cas A) should yield a measurable flux of harder x-ray quanta. The distance to the Large Magellanic Cloud is determined independently by a radio-astronomy method based on an analysis of sources observed there identifiable with type II supernova remnants. Such outbursts occur once every ≈10,000 yr in the Large Cloud. A theoretical radio-luminosity function is derived for type II supernova remnants in a galaxy. (auth)

11363 PREDICTED SECULAR LUMINOSITY VARIATION OF THE CRAB NEBULA AND THE FINE STRUCTURE OF ITS AMORPHOUS COMPONENT. Gordon, I. M. (Inst. of Radiophysics and Electronics, Academy of Sciences, Ukrainian SSR). Soviet Astron. AJ (Engl. Transl.), 10: 599-601(Jan.-Feb. 1967).

Translated from Astron. Zh., 43: 754-7(July-Aug. 1966).

Observations presently available indicate that the secular decline in the optical flux from the Crab Nebula predicted theoretically is absent. This absence may arise from the motion and acceleration of the "optical" electrons in the filaments of the amorphous component. The secular decline in the radiant flux at λ = 9.4 cm may result from motion of low-energy electrons in the tangled magnetic field between filaments. From λ = 1–30 cm the rate of decline in radiant flux should increase with decreasing percentage polarization. Several optical observations are suggested that could confirm a powerful acceleration process for relativistic electrons in the Crab, as x-ray observations also imply. (auth)

11364 HYPOTHESIS OF CORES RETARDED DURING EXPANSION AND THE HOT COSMOLOGICAL MODEL. Zeldovich, Ya. B.; Novikov, I. D. Soviet Astron. AJ (Engl. Transl.), 10: 602-3(Jan.-Feb. 1967).

Translated from Astron. Zh., 43: 758-60(July-Aug. 1966).

The existence of bodies with dimensions less than $R_g = 2GM/c^2$ at the early stages of expansion of the cosmological model leads to a strong accretion of radiation by these bodies. If further calculations confirm that accretion is catastrophically high, the hypothesis on cores retarded during expansion will conflict with observational data. (auth)

11365 CRITICAL STELLAR PARAMETERS. Bisnovatyi-Kogan, G. S.; Kazhdan, Ya. M. Soviet Astron. AJ (Engl. Transl.), 10: 604-12(Jan.-Feb. 1967).

Translated from Astron. Zh., 43: 761-71(July-Aug. 1966).

An approximate energy method is used to compute the points where stars of mass M = 5–1000 solar masses that have exhausted their nuclear fuel become unstable. Stars of constant entropy per unit mass are treated; an Emden polytrope with index n = 3 is adopted for the mass distribution. Similar computations for n = 1.5 yield less than 10% difference in S_{cr} and the central T_{cr} and ρ_{cr}. Isentropes in the region $1 < T_8 < 20$°K, $1 < \rho_8 < 10^5$ g/cm^3 are computed. The functions P, E, C_V, C_p/C_V, and γ along the isentropes are computed for lower temperatures and densities. The critical points are computed, allowing for small general-relativity effects. (auth)

11366 ANALYSIS OF THE SPECTRUM OF μ CEPHEI IN THE λλ 6600 TO 4250 A REGION. Orlov, M. Ya. (Main Astronomical Observatory, Academy of Sciences, Ukrainian SSR). Soviet Astron. AJ (Eng. Transl.), 10: 619-22(Jan.-Feb. 1967).

Translated from Astron. Zh., 43: 779-82(July-Aug. 1966).

The measured equivalent widths of the spectral lines of the superscript μ Ceph (M2Ia) in the region λλ 6600–4250 were used for constructing a growth curve. The abundances of a number of elements, electron pressure, damping constant, turbulent velocity, and parameters of the source function were determined. The results are compared with those obtained by Yamashita in the infrared region (λλ 8800–7200). (auth)

11367 COSMOLOGICAL MODEL WITH A DISORDERED MAGNETIC FIELD. Chernin, A. D. (Inst. of Technical Physics, Academy of Sciences, USSR). Soviet Astron. AJ (Engl. Transl.), 10: 634-6(Jan.-Feb. 1967).

Translated from Astron. Zh., 43: 797-9(July-Aug. 1966).

An exact analytic solution is given for the gravitation equations describing a model universe with a disordered magnetic field, and energy and mass densities homogeneous in the mean. The gravitational stability of the model is examined. (auth)

11368 ROTATING MASSIVE STARS IN GENERAL RELATIVITY. Durney, B. R. (High Altitude Observatory, Boulder, Colo.); Roxburgh, I. W. Proc. Roy. Soc. (London), Ser. A, 296: 189-200(Jan. 17, 1967).

Equilibrium models of uniformly rotating massive stars are investigated, using a weak field, slow rotation approximation, which is shown to be adequate for all cases of interest. The fate of radial perturbations about these equilibrium configurations is investigated using a linearized stability analysis to determine the oscillation frequency σ in a perturbation $\propto e^{i\sigma t}$. An eigenvalue equation for σ^2 is obtained which can be made self adjoint with respect to the spatial metric, and a variational principle to determine σ^2 is derived. Numerical determinations of σ^2 have been carried out for a variety of masses, radii and rotational velocities, and these results are incorporated in a simple formula that gives the dependence of σ^2 on these quantities. The condition for instability, σ^2 negative, is determined, and it is found that for large masses and maximum rotation velocity, so that when centrifugal force balances gravity at the surface, a massive star becomes unstable when its radius is 208 times the Schwarzschild radius $2GM/c^2$. (auth)

11369 POSSIBLE LARGE SCALE CLUSTERING OF QUASARS. Rees, M. J.; Sciama, D. W. (Cambridge Univ., Eng.). Nature, 213: 374-5(Jan. 28, 1967).

It has recently been pointed out that quasars with large red shifts do not appear to be distributed isotropically. Those with red shift Z > 1.5 are mainly confined to two regions, one near the North Galactic Pole and the other in the South Galactic Hemisphere. These groups each have an angular diameter of about 30°. Quasars with intermediate Z also appear to be distributed anisotropically, but with larger angular diameter. It has been suggested that, if future observations confirm these findings, then either (a) the universe is anisotropic for $Z \gtrsim 1$ or (b) quasars are not at cosmological distances. A third possibility (c) that the universe is inhomogeneous on a scale corresponding to $Z \sim 1$ is proposed. This seems more plausible than anisotropy, since the radio sources in the 4C catalogue are distributed isotropically, and the excess

microwave background, which probably comes from regions with $Z \gg 1$, appears to be highly isotropic. Moreover, the existence of large scale inhomogeneities is compatible with an overall homogeneous point source model of the universe. It is postulated that if clusters occupy about one-third of space, they would contain more than 80% of all quasars. Since quasars of low Z occupy a large region of the sky, it is likely that we are inside a cluster. These quasars are, however, more numerous relative to those of high Z in the Northern Galactic Hemisphere, hence we are presumably situated appreciably off-centre. A schematic diagram of a possible arrangement of clusters is depicted and various deductions made therefrom. (UK)

11370 ANISOTROPIC DISTRIBUTION OF QUASARS WITH LARGE RED-SHIFT. Penston, M. V. (Royal Greenwich Observatory, Herstmonceux, Eng.); Rowan-Robinson, G. M. Nature, 213: 375-7(Jan. 28, 1967).

It has been suggested that there is an anisotropy in the distribution of quasars with large red shift over the sky, most of those discovered to date falling in two regions near the galactic poles. Evidence is presented that this anisotropy may be merely an effect of observational selection. Attention is confined to sources identified from the revised 3C catalogue. The visual magnitudes of quasars identified from this catalogue are plotted against their flux densities at 1,400 Mc. Results suggest that red shift is correlated either with distance, as the cosmological theories and the simple single explosion local model require, or inversely with optical and radio luminosities. Hoyle and Burbidge have pointed out that there is no clear red shift magnitude relation for quasars either optically or at 178 Mc. This is not disputed, but it is claimed that most quasars with large red shift have faint apparent optical magnitudes and radio flux densities at 1,400 Mc. It is proposed that the primary anisotropy is in the distribution of quasars with $V \geq 18$, rather than of those with large red shifts. Possible causes of observational selection are stated. (UK)

11371 GRAVITATIONAL RED SHIFTS IN QUASI-STELLAR OBJECTS. Hoyle, F. (Inst. of Theoretical Astronomy, Cambridge, Eng.); Fowler, W. A. Nature, 213: 373-4(Jan. 28, 1967).

The very large energies associated with some radio sources imply the existence of supermassive objects and strong gravitational fields, and the discovery of large red shifts associated with quasi-stellar objects might be taken as confirming the existence of such strong fields. Greenstein and Schmidt, however, proposed an argument to show that these shifts are not of gravitational origin, and this argument has been considered as demonstrating the cosmological nature of the quasars. The purpose of this communication is to argue that whilst the conclusion of Greenstein and Schmidt is correct for their assumed model, a different model can be postulated, which permits a gravitational explanation for the red shifts. (UK)

11372 SOLAR WIND OUTSIDE THE PLANE OF THE ECLIPTIC. Dennison, P. A.; Hewish, A. (Cambridge Univ., Eng.). Nature, 213: 343-6(Jan. 28, 1967).

The scintillation of radio sources caused by the interplanetary medium offers a means of studying the motion of the solar wind well away from the plane of the ecliptic, where direct measurements have so far been confined. Observations from a triangular arrangement of radio receivers (on 81.5 Mc) suggest that the solar wind is faster over the solar poles than in the plane of the ecliptic. (auth)

11373 HOW TO COUNT QUASARS. Kafka, Peter (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nature, 213: 346-50(Jan. 28, 1967).

Bias in the counting of quasars can arise partly from the scatter of intrinsic brightness and partly because of the shapes of quasar spectra. The corresponding selection effects can be eliminated for any cosmological model assumed. This procedure will be important for the evaluation of future catalogues of radio sources. At present, no decision can be made, from a statistical count of quasars, between steady state and other cosmological models. (auth)

11374 ENHANCED INTERPLANETARY SCINTILLATIONS ASSOCIATED WITH SOLAR FLARES. Sharp, L. E.; Harris, D. E. (Cornell Univ., Ithaca, N. Y.). Nature, 213: 377-8 (Jan. 28, 1967).

A survey of radio sources at 195, 430, and 611 Mc has been undertaken at the Arecibo Ionospheric Observatory to determine the sources which scintillate as a result of irregularities in the interplanetary medium. The degree of intensity scintillations observed on the earth depends on the integrated fluctuations in the electron density along the line of sight in the interplanetary medium and on the scale size of these fluctuations. By monitoring sources which scintillate, some of the gross features of the interplanetary medium can be deduced. It should be possible to plot the passage of shock waves and the ejection of turbulent plasma associated with large solar flares, since the disturbance moves out from the sun into the interplanetary region. Some data obtained during periods of solar activity in 1966 are discussed. (UK)

11375 MECHANISM FOR RADIO GALAXIES AND QUASARS. McCrea, W. H. (Univ. of Sussex, Eng.). Nature, 213: 239-41 (Jan. 21, 1967).

A possible explanation of the phenomena associated with radio-galaxies and quasars is presented. Whilst this theory is speculative, it nevertheless succeeds in correlating many empirical properties without invoking any hitherto unknown processes or states of matter. It is suggested that gravitational collapse and thermonuclear processes, operating through the formation of many temporary stars, can provide a basis for a model of radio sources. The model may explain some of the properties of the sources and provide a unifying theory for quasars and radio-galaxies. (auth)

11376 NEUTRINO ASTRONOMY. Burbidge, Geoffrey. Endeavour, 26: 50-4(Jan. 1967).

The basic energy-releasing processes that are believed to go on in the stars release neutrinos and study of the resulting fluxes of neutrinos could give much information about these processes. In addition, neutrinos interact so rarely with other particles that it is possible to study the identical ones that were released in the star reaction. For the same reason, unfortunately, they are not easy to detect. This article describes the basis of neutrino astronomy and suggests the nature of the information it may be hoped to gain from it. (auth)

11377 EVIDENCE FOR A CORRELATION BETWEEN THE POSITION AND RED-SHIFT OF QUASARS. Strittmatter, Peter (Inst. for Theoretical Astronomy, and Peterhouse, Cambridge, Eng.); Faulkner, John; Walmsley, Malcolm. Nature, 212: 1441-2 (Dec. 24, 1966).

It is often assumed that quasars are partaking in the general expansion of the substratum of an isotropic universe. This hypothesis requires that those quasars possessing any particular observational property should be randomly distributed over the sky. Evidence is presented which suggests that for at least one such property, the red shift, quasars may be ordered in sets of decreasing isotropy. If further observations should continue to support this result, the simple cosmological explanation of quasar red shifts may have to be abandoned in favour of (a) an anisotropic universe or (b) a more local and possibly galactic origin for quasars. (auth)

11378 OBSERVATIONS IN H_α AND D_3 OF DARK STRUCTURES IN PROMINENCES. Gahm, Goesta. Ark. Astron., 4: 169-72(1966).

By observing simultaneously in H_α and D_3 one should be able to decide whether the dark prominences are situated in front of bright prominences or inside the same. In order to test such a method and get more observations of these objects, simultaneous observations in H_α and D_3 were made during the period March 23 to July 1, 1965. (W.D.M.)

11379 INFLUENCE OF THE SLIT SIZE ON MEASUREMENTS WITH A SOLAR MAGNETOGRAPH. Stenflo, Jan Olof. (Univ. of Lund, Sweden). Ark. Astron., 4: 173-98(1966).

The general magnetic field of the sun was studied with the magnetograph of the Crimean Astrophysical Observatory. Small regions near the poles of the Sun were scanned using four different sizes of the spectrograph slit (2″ × 27″, 2″ × 9″, 3″ × 4.5″ and 3″ × 2.3″). A very strong dependence of the recorded magnetic field on the size of the slit was found. Of special interest is the increase of the average net flux, when smaller slits are used. With the smallest slit, the average polar field was found to be about 5 gauss. Since the net field is increasing for smaller slit sizes, the real strength of the polar field is likely to be greater, a result which differs substantially from earlier measurements with large slits, e.g., Babcock, who found a polar field of the order of 1 gauss. The fine structure of the polar fields is very pronounced. There is a difference in character between magnetic elements at the north and south pole of the sun as well as between elements of north and south polarity, these differences being found with all the slits. (auth)

11380 ORIGINS OF FOSSIL CHARGED-PARTICLE TRACKS IN METEORITES. Fleischer, R. L. (General Electric Research and Development Center, Schenectady, N. Y.); Price, P. B.; Walker, R. M.; Maurette, M. J. Geophys. Res., 72: 331-53 (Jan. 1, 1967).

The possible origins of naturally occurring (fossil) charged-particle tracks in meteorites are considered. The fact that only particles with a large rate of ionization loss give revealable tracks in common silicate minerals restricts the sources of

meteoritic tracks to the following possibilities: (a) slowed-down heavy cosmic-ray primaries, (b) spontaneous fission of ^{238}U and extinct ^{244}Pu, (c) induced fission of heavy elements by cosmic rays, (d) spallation recoils, (e) meson jets, and (f) magnetic monopoles. The last two potential sources are probably not important. The other sources are shown to produce characteristic track features that allow the dominant source to be uniquely identified in individual meteorites—provided the appropriate calibration experiments are performed. Two important applications of fossil meteoritic tracks are the determination of the abundance of extremely heavy cosmic rays and the measurement of the cool-down time of bodies in the early solar system. (auth)

11381 THE OCCURRENCE OF SINGULARITIES IN COSMOLOGY. II. Hawking, S. W. (Cambridge Univ., Eng.). Proc. Roy. Soc. (London), Ser. A, 295: 490-3(Dec. 20, 1966).

It is shown that if the universe has a compact Cauchy surface on which the density is nonzero and if the energy–momentum tensor satisfies a physically reasonable inequality, then singularities of space–time are inevitable. (auth)

11382 TRACKS OF HEAVY PRIMARY COSMIC RAYS IN METEORITES. Fleischer, R. L. (General Electric Research and Development Center, Schenectady, N. Y.); Price, P. B.; Walker, R. M.; Maurette, M.; Morgan, G. J. Geophys. Res., 72: 355-66(Jan. 1, 1967).

Tracks of primary cosmic rays with atomic number $\gtrsim 20$ were identified in 23 out of 42 meteorites of various types. They satisfy the criteria of rapid attenuation with depth, directional anisotropy, proper length distribution, proper absolute number, and equal numbers in adjacent minerals with widely different uranium contents. From measurements of track densities in samples of meteorites with known cosmic-ray age, the original depths of the samples below the preatmospheric surfaces of the meteoroids were obtained. These ranged from ~3 to 50 cm. Minimum values of the preatmospheric radii ranging from 10 to 55 cm were also obtained. Using a computed relationship between track lengths and particle mass, the observed distribution of track lengths was used to infer the existence of cosmic rays that are considerably heavier than iron. The relative abundance of cosmic rays with $Z \gtrsim 32$ was estimated to be ~1:4000 that of the iron group ($20 \leq Z \leq 30$). (auth)

11383 ORIGIN OF THE ELEMENTS. Tayler, R. J. (Cambridge Univ., Eng.). Rep. Progr. Phys., 29: 489-538(1966).

Observations of element abundances in different astronomical objects indicate that hydrogen and helium are very much more abundant than all of the other elements put together. This suggests that the light elements may have been created cosmologically while the heavier elements have been produced in subsequent astrophysical processes. A satisfactory discussion of the origin of the elements thus involves a decision about which cosmological model is valid and an understanding of how much element synthesis occurs in the various astronomical objects. The progress that has so far been made with this problem is reviewed. The observations of element abundances are first reviewed and a discussion is given of the uncertainties involved in converting raw observations into abundances. An account is given of several cosmological theories. The main discussion centers on whether only hydrogen or both hydrogen and helium were created cosmologically, but other factors which may cause cosmological theories to be discarded are also mentioned. Some nucleosynthesis certainly occurs in stars, but it is still not clear that ordinary stars are the main site of the synthesis of all elements other than hydrogen and helium. It is stressed that it is not only necessary for nucleosynthesis to occur in astronomical objects but that the processed material must be expelled into space so that subsequent use can be made of it. Observations of element abundances and theories of element production cannot be more accurate than the physical laws and parameters which enter into them. The physical parameters with uncertain values, which are important in a discussion of the origin of the elements, are listed. (auth)

11384 COSMOLOGICAL MODELS AND THEIR OBSERVATIONAL VALIDATION. Davidson, W. (Univ. of Otago, Dunedin, New Zeal.); Narlikar, J. V. Rep. Progr. Phys., 29: 539-622 (1966).

The observational data of cosmology are presented in considerable detail and their interpretation in terms of various cosmological models is described. The data survey the nature and cosmic distribution of luminous matter (galaxies), radio sources, quasars, intergalactic matter, the radio and optical background radiation, x rays, γ rays and cosmic rays. The theoretical basis of cosmological models is described in its general aspects and in particular cases. Topics discussed include the homogeneous anisotropic models, isotropic models, Mach's principle, relativistic cosmology, Newtonian cosmology and the various versions of the steady-state theory and creation of matter. Theoretical observable relations are derived or described for the isotropic models of relativistic cosmology and the steady-state theory. (auth)

11385 DAILY INDEX OF SOLAR FLARE ACTIVITY. Sawyer, Constance B. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). J. Geophys. Res., 72: 385-91 (Jan. 1, 1967).

A daily flare index that is similar to the index of solar flare activity originally published by the High Altitude Observatory is defined and computed. The H.A.O. index measures the integrated intensity of flare radiation, and the new index shares its clear physical interpretation and parallels geophysical effects in a similar way. The Square Disturbances Laboratory Index I_f is based on complete worldwide standardized flare data and is defined as a function of the single variable flare area. This simple definition is made possible by the fact that the duration of the observable flare is related to apparent area independently of the flare's position on the solar disk. Characteristics of the index I_f are compared to those of other flare indices. (auth)

Atomic and Molecular Physics

Refer also to abstracts 11656, 11682, 12034, and 12056.

11386 (DESY–66/37) MONOENERGETIC BREMSSTRAHLUNG WITH LINEAR POLARIZATION CLOSE TO 100 PERCENT FROM THIN CRYSTAL TARGETS. Lutz, Gerhard (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Nov. 1966. 22p. Dep. mn.

Mozley and de Wire have pointed out that bremsstrahlung from thin crystals can be monochromatized if one strongly collimates the photon beam. In recent papers it was shown that the linear polarization of uncollimated coherent bremsstrahlung can be raised if the crystal is orientated in such a manner that one gets the main contribution to the spectrum from one single reciprocal lattice point only. Here it is shown that by combining this method of orientation of the crystal with strong collimation one gets not only one dominating monoenergetic spike in the spectrum due to this single reciprocal lattice point, but that, in addition, the polarization of the spike is increased to a very high value. A simple procedure is given for deriving these spectra and their polarization from some "universal" curves for silicon and diamond crystals. An estimate is given of the photon intensity which can be reached by this method. (auth)

11387 (FFN–60) ATOMIC MOTION IN LIQUID ARGON. Skoeld, K.; Larsson, K. E. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Nov. 28, 1966. 46p. (CONF-650676–2). Dep. mn.

From Conference of the Swedish National Committee for Physics, Uppsala, Sweden.

The atomic motion in liquid argon at 94°K was investigated by inelastic scattering of 4.1 Å neutrons. Special attention was paid to the collective aspects of the motion and the observations were therefore confined to momentum transfers in the region $1.3 < \kappa < 3.3$ Å^{-1} which includes the main peak of the liquid structure factor. The results are compared to various models. These comparisons give strong evidence of collective modes and an extreme polycrystalline model, in which even the polarization of the phonons is retained, gives the best description of the data. There is also definite evidence of a second Brillouin zone in liquid argon. A dispersion relation with a slope close to the measured velocity of sound and in good agreement with earlier neutron results is obtained. The frequency spectrum was determined and compared to the results of a computer calculation by Rahman. (auth)

11388 (IPP–1/54) BINDING ENERGIES OF THE NEXT INNER SUBSHELL OF ATOMS AND IONS FROM B TO Zn. Lotz, Wolfgang (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Oct. 1966. 21p. Dep. mn.

Binding energies of the next inner subshell are given for most ionization stages of the elements boron through zinc ($Z = 30$). These binding energies are calculated along isoelectronic sequences with full regard to experimental values. Similarities in the periodic table are taken into account. (auth)

11389 (JILA–89) ELECTRON COLLISIONS WITH POSITIVE IONS. Bely, Oleg (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Nov. 21, 1966. 44p. (AROD–4445:66; (CONF-660721–1).

From International Astronomical Union Commission 14-Subcommittee on Atomic Collision Cross Sections, Boulder, Colo.

The excitation of positive ions by electrons is discussed. The classical and semiclassical methods which apply to the excitation

of neutral atoms are also discussed. The eigenfunction expansion method is discussed in particular. (M.O.W.)

11390 (JINR-P4-3072) REAKTSIYA PEREZARYADKI π^--MEZONA NA YADRAKH SVYAZANNOGO VODORODA. (Charge Exchange of Negative Pion on Bound Hydrogen Nuclei). Ponomarev, L. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 10p. (In Russian). Dep. mn.

A model of large mesic molecules, which was suggested earlier is developed. New experiments and the consequences of the model, which may be useful while analyzing these experiments, are discussed. (auth)

11391 (N-66-19088) ELECTRON BEAM COMPRESSION WITH ELECTRIC AND MAGNETIC FIELDS. Talbot, K. I.; Johnson, C. C. (Utah Univ., Salt Lake City. Microwave Device and Physical Electronics Lab.). Aug. 1964. 14p. (NASA-CR-70365). CFSTI $3.00 cy, $0.65 mn.

A combined electrostatic and magnetostatic compression system may be used to yield electron beams of very small diameters and very large current and power densities. Analytical results were obtained which give design curves for a minimum ripple beam. Small design error effects in initial beam slope and radius were investigated as well as effects due to thermal velocities and cathode flux. Experimental results were obtained on a perveance 2.4×10^{-6} beam operating at 10 kV. A final beam diameter of .013 inches was obtained in a magnetic field of 7500 gauss. An area compression of 1350 : 1 was obtained with a final current density at 2000 A per square centimeter. The beam size was detected by copper collector erosion patterns and holes burned in carbon paper discs. (STAR)

11392 (N-66-23601) CROSS SECTION FOR ENERGY TRANSFER BETWEEN TWO MOVING PARTICLES. Gerjuoy, Edward (Pittsburgh Univ., Pa. Space Research Coordination Center). Mar. 21, 1966. 73p. (NASA-CR-74137; SRCC-25). CFSTI $3.00 cy, $0.65 mn.

The classical cross section, for producing a specified energy transfer in the collision of two particles having arbitrary masses and velocities in the laboratory system, is derived. The effective average (for fixed speeds) of the cross section over all directions of the particle velocities is then computed. These results are required in the classical calculations of atomic collision cross sections via the procedures recently proposed. The method will yield the average of any force over all directions of the particle velocities. (auth)

11393 (NASA-SP-3036) ADDITIONAL STOPPING POWER AND RANGE TABLES FOR PROTONS, MESONS, AND ELECTRONS. Berger, Martin J.; Seltzer, Stephen M. (National Bureau of Standards, Washington, D. C.). 1966. 40p. CFSTI $3.00 cy, $0.65 mn.

A supplement to earlier tabulations in NAS-NRC-1133 is presented. Data are given for liquid hydrogen, lithium fluoride, silicon, germanium, propane, and freon. In addition, earlier tables for electrons in muscle and bone are corrected. (W.D.M.)

11394 (ORNL-P-2569) PSEUDO-ATOM PHASE SHIFTS OF LIQUID METALS AND ALLOYS. Meyer, Axel; Nestor, C. W. Jr. (Oak Ridge National Lab., Tenn.); Young, W. H. (Sheffield Univ. (England). Dept. of Physics). [1966]. Contract W-7405-eng-26. 20p. (CONF-660935-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Conference on Properties of Liquid Metals, Upton, N. Y.

Ziman pseudo-atom phase shifts have been evaluated, as functions of l and k_F, for monovalent ions, using a pseudopotential technique. The results of their application to a number of physical problems suggest that the data are reasonably accurate. (auth)

11395 WORK FUNCTION OF TUNGSTEN SINGLE CRYSTALS. Love, H. M.; Wilson, J. R. (Queen's Univ., Kingston, Ont.). Can. J. Phys., 45: 225-7(Jan. 1967).

Measurements were made of the work functions of emitter and collector ribbons of single-crystal tungsten in an ultrahigh vacuum system. Richardson plots of the data gave a collector work function of 4.15 ± 0.07 V and a Richardson constant A of $1.05 \pm 0.5 \times 10^5$ A/m^2(°K)^2. The contact potential and emitter work function were determined to be 162 ± 2 mV and 4.31 ± 0.07 V, respectively. The collector had the (311) plane 5° from the surface, while the emitter (310) plane was within 1° of the surface. (D.L.C.)

11396 OCTOPOLE HYPERFINE INTERACTION CONSTANTS. Malli, Gulzari; Fraga, Serafin (Simon Fraser Univ., Burnaby, B. C. Univ. of Alberta, Edmonton). Can. J. Phys., 45: 219-20 (Jan. 1967).

Octopole interaction constants are evaluated from analytical Hartree-Fock functions for Ga and Cl. The agreement for Cl is excellent, while for Ga the discrepancy is larger. It appears that, when calculating the octopole interaction constants, Hartree-Fock functions satisfying the cusp conditions exactly should be used. (M.H.R.)

11397 ELECTRON COLLISION STUDIES WITH TRAPPED POSITIVE IONS. Baker, F. A. (Institut Battelle, Geneva); Hasted, J. B. Phil. Trans. Roy. Soc. London, Ser. A, 261: 33-65(Oct. 13, 1966).

Experimental techniques for studying ionization and excitation of positive ions by electrons are discussed, particularly those whereby an electron beam is passed through a region in which positive ions are held trapped by an electric or magnetic field. The space charge of the electron beam can conveniently be utilized to form the trapping field. The theory of such experiments is outlined and results are reported on measurements on the ionization of Ne^+, Ar^+, Kr^+, Xe^+, Ne_2^+, CO^+, and the dissociation of CO^+ and CH_4^+ by low-energy electrons. Certain other collision processes can also be investigated by this method, and proposals are made for more extended study. These positive ions were trapped for periods of ~10 μsec within the space charge of a magnetically confined electron beam, ionized by this beam, and detected mass-spectrometrically. Cross section functions are given for the ionization of Ne^+, Ar^+, Kr^+, Xe^+, and the dissociation of CO^+ by electrons. From measurements of fragment ion currents CH_2^+, CH^+ from methane, it was shown that the dissociation of CH_4^+ by electrons can contribute unwanted effects interfering with the appearance potential of the fragment ion. Effects due to excitation of ions by electrons were observed in the noble gases. (BBB)

11398 EXCITATION OF LITHIUM-LIKE IONS BY ELECTRON IMPACTS. II. TRANSITIONS 2s → ns AND 2s → nd. Bely, O. (Joint Inst. for Laboratory Astrophysics, Boulder, Colo.). Ann. Astrophys., 29: 683-7(Nov.-Dec. 1966).

Using the Coulomb-Born approximation, the excitation cross sections Q(2s → ns) and Q(2s → nd) in some lithium-like ions up to n = 7 are computed. The extrapolation to any n and to any ion of this series is trivial. The results are discussed. It turns out that if one considers the different multipolar cross-sections Q(2s → nL = λ), λ = 0,1,2, . . . for n ≠ 2, the dipole cross-section Q(2s → np) is no longer the largest one. For example, the quadrupole cross-section Q(2s → nd) is found to be always larger than Q(2s → np). (auth)

11399 ISOTOPE SHIFT IN THE RESONANCE LINES OF THE ARC SPECTRUM OF ^{133}Cs, ^{135}Cs, AND ^{137}Cs. Huehnermann, H.; Wagner, H. (Univ., Marburg, Ger.). Z. Phys., 199: 239-43 (1967).

Reactor Cs and mixtures of electromagnetically enriched Cs were used to investigate the isotopic shift of the two resonance lines. By a digital evaluation method anomalies in the isotope shift were found. (auth)

11400 THE SOLUTION OF THE EQUATION OF THE DEGRADATION OF THE ENERGY OF γ IRRADIATION. El'tekov, V. A. Vestn. Moskov. Univ., Ser. III: Fiz. Astron., No. 4, 15-9 (July-Aug. 1966). (In Russian).

Numerical methods for the solution of the integral equation of γ scattering were considered. A new method for the solution of this equation was proposed and its advantages in comparison with the usually used methods were indicated. (tr-auth)

11401 PLASMA DENSITY DEPENDENCE OF RF ION SOURCES. Ogawa, Kazuyuki; Kawasaki, Shinsuke (Central Research Lab., Tokyo. Shibaura Electric Co., Ltd., Kawasaki, Japan). Jap. J. Appl. Phys., 6: 279-80(1967).

It was confirmed that the ion current extracted from a rf ion source is proportional to the plasma density at the boundary and also to the intensity of the longitudinal magnetic field added to the source. Voltage-current characteristics of a 100-Mc ion source are given. (M.O.W.)

11402 TOTAL CROSS SECTIONS FOR THE SCATTERING OF POTASSIUM BY HELIUM, NEON, ARGON, KRYPTON, AND XENON. Kusunoki, Isao (Kyoto Univ.). Bull. Chem. Soc., Jap., 40: 69-75(Jan. 1967).

Total cross sections for the scattering of potassium by He, Ne, Ar, Kr, and Xe were measured in the thermal energy range. The potassium beam and the scattering gases had Maxwellian velocity distributions. The angular resolution of the apparatus was 2.62 min of arc, so that quantum mechanical calculations could be applied. If a van der Waals potential, $V = -C/r^6$, is assumed for the long range intermolecular forces, the total cross section may be related to the constant, C, as follows; $Q(v_r) = p[C/\hbar v_r]^{1/3}$, where p is a constant. Care was taken to avoid the pumping effect of a McLeod gage in measurement of the pressure in the scattering chamber. The Ga_0 function defined by Berkling et al. was used to derive an absolute total cross section from a measured effective total cross section. The van der Waals constants calculated from the measured total cross sections were compared with the theoretical

values. The present values were about 25 percent smaller than the theoretical values for the Ar, Kr, and Xe systems. The differences for the He and Ne were considerably larger, with the theoretical values larger than the experimental by a factor of two or three. (auth)

11403 SLOW-ELECTRON-BEAM ATTENUATION BY GOLD FILMS. Kanter, H. (Aerospace Corp., El Segundo, Calif.). Appl. Phys. Lett., 10: 73-5(Feb. 1, 1967).

An attenuation length of 34 Å for electrons with 6-eV energy above the Fermi level was found by penetration of slow-energy electron beams through gold films about 200-Å thick. The collector current was determined for various primary energies as a function of film thickness, which was increased in situ by vapor deposition. The attenuation length, representative of electron-electron collisions, decreased to 29 Å, for an increase of energy of 1 eV. (auth)

11404 ELECTRICAL RESISTIVITY CHANGES IN THIN METALLIC FILMS DUE TO ION IRRADIATION. Navinsek, B.; Carter, G. (Univ. of Liverpool). Appl. Phys. Lett., 10: 91-2 (Feb. 1, 1967).

The change in electrical resistance of thin Ag, Au, Ti, and W films was studied following energetic Ar^+ ion bombardment. There is an initial reduction in film resistance (for all materials) during bombardment, which is attributed to removal of surface contaminant gas. The resistance then increases to a quasiequilibrium value, which is believed to be due to introduction of radiation damage to the films, and finally the resistance increases rapidly as the films sputter and thin. (auth)

11405 SELF-CONSISTENT FIELD THEORY FOR POSITIVE IONS. Fraga, Serafin; Malli, Gulzari; Valdemoro, Carmela (Univ. of Alberta, Edmonton, Can.). Theoret. Chim. Acta, 6: 122-30(1966).

Certain numerical characteristics for Hartree–Fock functions are discussed with reference to the numerical values found for neutral systems and negative ions. They are almost constant, with oscillations within a very small range. On the other hand the discrepancies observed for positive ions increase with the number of positive charges. An investigation of the possible reasons for such difference indicated that the functions for positive ions should be determined through a formalism different from that used for neutral systems and negative ions. The development of this formalism involved a series of considerations. First, an examination of the stability conditions for Hartree–Fock functions showed that it is legitimate to have orbital energies that are identically zero. This fact made possible a new formulation, in which constraints are introduced as the orbital energies of the ionized electrons will be precisely zero. The mathematical formulation makes use of the fact that there is no need to introduce the orthonormality constraints in the variational treatment, as shown earlier by Fraga and Malli, but instead using any other constraint, following the formulation of Fraga and Birss. After this treatment the only question that remains to be solved is that concerning the symmetry and occupancy of the ionized orbitals. It is believed that it is more appropriate to assume they belong to the same symmetry designation as the orbitals in the groundstate of the neutral system from which the electrons have be ionized. Regarding the occupation numbers, it must be considered that single occupancy of the ionized orbitals is in better agreement with the true situation. (BBB)

11406 KINETICS OF DISSOCIATION OF CARBON DIOXIDE MOLECULES BEHIND A SHOCK-WAVE FRONT. Losev, S. A.; Terebenina, L. B. Zh. Prikl. Mekh. Tekh. Fiz., No. 4, 133-8 (July-Aug. 1966). (In Russian).

The kinetics of carbon dioxide dissociation at high temperatures (up to 6000 K) are studied by considering the problem of gas molecule dissociation in flows behind a shock-wave front propagating in pure CO_2. It is assumed that equilibrium with respect to all internal degrees of freedom is established very rapidly behind the shock-wave front. The distribution of thermodynamic properties and concentrations of gas components behind the shock-wave front were calculated by the Runge–Kutta method on a computer for 30 sets of shock wave velocities and gas pressures. The mole fractions of gas components at To = 4450K at p = 0.188 atm for various values of the second reaction rate constant K_2, and the specific reaction rates for three reactions are given in graphs. They show the early prevalence of the first reaction (1 μsec), then the development of the second which may overcome the first, while the effect of the third reaction is relatively small. The theoretical results were substantiated by experiments carried out with CO_2 in a shock tube. The state of the gas was determined by measuring the degree of absorption of ultraviolet radiation due to the passage of shock waves. An analysis of the results shows that dissociation process behind the shock wave front at velocities V ~ 30 to 4 km/sec at near-atmospheric pressure begins with the reaction $CO_2 + CO_2 \rightarrow CO + O + CO_2$, then very rapidly (in a fraction of a microsecond), enough oxygen atoms are produced to start the second reaction $CO_2 + O \rightarrow CO + O_2$. After 2 or 3 μsec, the rates of both reactions are practically equal and from then on the reaction $CO_2 + CO_2 \xrightarrow{K_2} 2CO + O_2$ takes place. Consequently, the part of the second reaction in the kinetics of CO_2 dissociation is significant. It is concluded that calculations carried out here confirm the possibility of experimental determination of the first reaction rate constant at the very beginning of the equilibrium zone ($t \leq 1$ μsec) where the part of the second reaction is still small. (ATD)

11407 THE HIGH-ENERGY BEHAVIOUR OF THE CROSS SECTION FOR CHARGE EXCHANGE. McCarroll, R.; Salin, A. (Observatoire de Paris, Meudon, France). Proc. Phys. Soc. (London), 90: 63-72(Jan. 1967).

It is shown that the recent treatment by McCarroll and Salin of atomic excitation by proton impact is the quantal equivalent of the continuum distorted wave approximation of Cheshire. The consequences of this are examined in detail for the charge exchange reaction $H^+ + H(1s) \rightarrow H(1s) + H^+$. The origin of certain small discrepancies between the impulse and the continuum distorted wave approximations in the high-energy limit is discussed. The importance of using wave functions with the correct asymptotic form is particularly stressed. While physically evident that the internuclear potential can play no significant role in an electronic transition, it is necessary to assure that, in any theoretical treatment, the internuclear potential be retained or omitted in a consistent way. (auth)

11408 INELASTIC COLLISIONS BETWEEN HYDROGEN AND HELIUM ATOMS. Bates, D. R.; Crothers, D. S. F. (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 90: 73-80(Jan. 1967).

An approximation devised by Ochkur and Rudge for the treatment of exchange in electron–atom collisions is adapted and applied to atom–atom collisions. In this approximation a fast projectile hydrogen atom is proved to be equivalent to a projectile electron of the same speed as far as producing multiplicity charge transitions in a target atom is concerned. The cross sections for H(1s) + $He(1s^2\ ^1S) \rightarrow H(\Sigma) + He(1snl\ ^{1,3}L)$, where nl ^{1,3}L is 2s ^{1,3}S, 2p ^{1,3}P, 3p ^{1,3}P or 3d ^{1,3}D, are calculated. The calculated 3d ^{1,3}D cross sections are much too low (as are the corresponding cross sections in the case of excitation by electron impact). It is suggested that this may be due to the neglect of coupling effects. There is quite good accord between the calculated 3p ^{3}P cross sections and the measured values of van Eck et al. Reliable laboratory data are not available for the other cross sections. (auth)

11409 ADVANCES IN ATOMIC AND MOLECULAR PHYSICS. VOLUME 2. Bates, D. R.; Estermann, Immanuel (eds.). Advances At. Mol. Phys., 2: 1-484(1966).

Seven chapters present discussions on the following areas: the calculation of Van der Waals interactions, thermal diffusion in gases, spectroscopy in the vacuum ultraviolet, the measurement of the photoionization cross sections of the atomic gases, theory of electron-atom collisions, experimental studies of excitation in collisions between atomic and ionic systems, and mass spectrometry of free radicals. (M.O.W.)

11410 PLASMA FREQUENCY AND VELOCITY SPREAD IN BUNCHED ELECTRON BEAMS OF FINITE DIAMETER. Mihran, Theodore G. (General Electric Co., Schenectady, N. Y.). J. Appl. Phys., 38: 159-66(Jan. 1967).

The velocity spread existing on a velocity-modulated electron beam of finite diameter is investigated as a function of drive, drift length, and perveance using a digital computer program based on a disk electron model. At small signal levels the velocity modulation decreases cosinusoidally to zero with drift distance in accordance with one-dimensional bunching theory. At higher signal levels, however, the velocity spread does not go to zero due to aberrations introduced by the finite diameter of the beam. The minimum velocity spread at maximum bunching is found to be proportional to the square of the fundamental component of rf current, up to an optimum drive level. Above this drive level the velocity spread increases rapidly with no corresponding increase in rf current. Trajectories of electrons of all initial phases are found to undergo a basic transition from nonovertaking to overtaking at a new characteristic distance $\lambda_{pq}/4$, which is given approximately by the geometric mean of the infinite beam quarter-plasma wavelength $\lambda_p/4$ and the reduced (due to finite beam size) quarter-plasma wavelength $\lambda_q/4$. This characteristic distance is found to be a key parameter in the prediction of velocity spread, drift length and drive for optimally bunched electron beams for use in klystron amplifiers, harmonic generators, and in linear accelerators. (auth)

11411 SCATTERING OF LOW-ENERGY NOBLE GAS IONS FROM METAL SURFACES. Smith, David P. (Minnesota Mining and Mfg. Co., St. Paul). J. Appl. Phys., 38: 340-7(Jan. 1967).

The energy distributions of positive ions ejected from polycrystalline Mo and Ni by He^+, Ne^+, and Ar^+ primary ions in the energy range of 0.5 to 3.0 keV have been found to consist of a low-energy distribution characteristic of sputtered ions and a sharp peak at higher energy. These high-energy ions are shown to be primary ions which have experienced single two-body collisions with the surface atoms. Multiply charged ions were not detected. It was found that, approximately, a monolayer of adsorbed gas was sufficient to prevent the detection of incident ions which have scattered from the metal target atoms. He^+ primary ions have been used to identify CO as an adsorbed gas on the Ni surface. Furthermore, the data suggest that the CO molecule forms a linear bond with the Ni surface through the C atom, as has been previously observed by other techniques. In contrast, when more reactive gas ions were used as primaries, nonsharp or continuous scattered ion energy distributions were observed, suggesting that lower neutralization probabilities associated with these ions allow the detection of ions which have penetrated deeply into the surface and emerged with varying energy losses. (auth)

11412 ELECTRON ATTACHMENT-DETACHMENT PROCESSES IN DRY AIR. Ryzko, Henryk; Astroem, Ernst (Uppsala Univ.). J. Appl. Phys., 38: 328-30(Jan. 1967).

The pulses due to electron avalanches released in dry air from a cathode of a uniform field gap (6 cm) by photoelectrons in a time interval of about 40 nsec are investigated. Using a new method of evaluation which yields simpler formulas, the attachment coefficient η for formation of unstable negative ions and the mean lifetime τ of these ions are determined. In the pressure range 4 to 60 torr, η/p is independent of pressure and increases in the E/p range 33 to 53 V cm^{-1} $torr^{-1}$ from 0.006 cm^{-1} $torr^{-1}$ to 0.017 cm^{-1} $torr^{-1}$. In the same pressure range, τp is independent of pressure and decreases from 35 μsec torr to about 2 μsec torr. The results confirm the earlier assumption of one prevailing kind of unstable negative ion. The value of η/p agrees with that obtained earlier at E/p close to 40 V cm^{-1} $torr^{-1}$. A distinct variation of η/p with E/p, not reported earlier, is obtained. (auth)

11413 A NOTE ON THE TOTAL IONIZATION CROSS SECTION FOR ELECTRONS IN THE INERT GASES AND CARBON MONOXIDE. Srinivasan, V.; Rees, J. A. (Univ. of Liverpool). Brit. J. Appl. Phys., 18: 59-64(1967).

Measurements are reported of the total ionization cross section for argon and carbon monoxide for electrons of energies from the first ionization potential to 100 eV. The measurements were obtained using a Tate and Smith type of apparatus and the results were corrected for McLeod gauge pumping errors. The results support the recent work of Rapp and Englander-Golden. Comparative cross-section data for the inert gases reported previously by Asundi and Kurepa have been renormalized and the results are briefly discussed. (auth)

11414 PHOTOIONIZATION OF THE HELIUM ATOM. Bell, K. L.; Kingston, A. E. (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 90: 31-7(Jan. 1967).

The photoionization cross section of helium is evaluated using six-parameter and twenty-parameter Hylleraas-type ground-state wave functions and a polarized-orbital continuum wave function in the dipole length and velocity formulations. The results are compared with other theoretical calculations and experimental data. It is concluded that the calculations are accurate to about 3%. The newly calculated cross section agrees with the experimental data to within experimental error from threshold at 504 Å to 40 Å. (auth)

11415 INFLUENCE OF ASYMMETRICAL ANGULAR SCATTERING ON THE MEAN NUMBER OF ELECTRON-HELIUM-GAS-ATOM ELASTIC COLLISIONS. Fleming, R. J. (Royal Military Coll. of Science, Shrivenham, Eng.). Proc. Phys. Soc. (London), 90: 43-9(Jan. 1967).

The mean number of elastic collisions $\bar{c}$ involving helium gas atoms and an electron diffusing between two infinite perfectly absorbing planar electrodes has been calculated, using Monte Carlo techniques, taking into account the asymmetrical angular elastic scattering distribution in helium. The influence of this distribution on the $\bar{c}$ values is compared with an earlier prediction by Maier-Leibnitz, based on the work of Didlaukis; the present results do not support Maier-Leibnitz's proposal that, in the Harries-Hertz formula, the square of the total elastic collision cross section should be replaced by the product of the total cross section and the momentum transfer cross section. It is suggested that, at higher gas pressures where the Harries-Hertz formula is applicable, the square of the latter cross section is more appropriate. (auth)

11416 ELASTIC CROSS SECTIONS OF HYDROGEN ATOMS. Fox, J. W.; Gal, E. (London Univ.). Proc. Phys. Soc. (London), 90: 55-61(Jan. 1967).

Differential and total elastic cross sections for the collision of unpolarized beams of hydrogen atoms have been evaluated for energies of the relative motion up to 0.37 eV ($ka_0 = 5$). The cross sections have been calculated from accurate phase shifts derived from numerical integration of the radial wave equations using the interaction potentials of Dalgarno and Lynn. The effect of the identity of the atoms has been investigated. (auth)

11417 MEASUREMENTS OF IONIZATION AND ATTACHMENT COEFFICIENTS IN CHLORINE. Bozin, S. E.; Goodyear, C. C. (Univ. of Liverpool). Brit. J. Appl. Phys., 18: 49-57 (1967).

Ionization and attachment coefficients, α and η, have been obtained by observing, in pure chlorine at pressures of 1 to 10 torr, the variation of pre-breakdown ionization currents with the distance between parallel electrodes at reduced fields in the range 70 to 150 V cm^{-1} $torr^{-1}$. Values of $\alpha - \eta$ have been obtained for values of E/p up to 250 V cm^{-1} $torr^{-1}$. The reduced coefficient a/p rises from 0.22 at E/p = 70 to 2.0 at E/p = 150, while η/p falls from 0.84 to approximately 0.25 in the same range. No pressure dependence could be found. These values of the attachment coefficient are much larger than those indicated by an extrapolation of the results of Bailey and Healey. (auth)

11418 THRESHOLD STRUCTURE IN ELECTRON EXCITATION FUNCTIONS OF HELIUM. Heddle, D. W. O. (Univ. of York, Eng.). Proc. Phys. Soc. (London), 90: 81-6(Jan. 1967).

It has been suggested by Bogdanova and her colleagues that the threshold structure observed in certain of the electron excitation functions of helium is due to secondary processes and is not characteristic of the electron-helium-atom interaction. Their explanation is shown to be inconsistent with the work of many other authors and an explanation in terms of the effects of space charge in the collision chamber is offered. (auth)

11419 THE DETERMINATION OF X-RAY TEMPERATURE FACTORS FOR ALUMINIUM AND POTASSIUM CHLORIDE SINGLE CRYSTALS USING NUCLEAR RESONANT RADIATION. Butt, N. M.; O'Connor, D. A. (Univ. of Birmingham, Eng.). Proc. Phys. Soc. (London), 90: 247-52(Jan. 1967).

The elastic scattering of 14.4 keV gamma rays from ^{57}Fe by single crystals of aluminium and potassium chloride has been measured as a function of Bragg angle and temperature using the Mössbauer effect to distinguish between the elastic and inelastic scattering processes. From the results, using the Debye model, Debye temperatures of 202 ± 5°K for KCl and 387 ± 14°K for Al were obtained. (auth)

11420 ATOMIC PHOTOABSORPTION CROSS SECTIONS. Brandt, Werner (New York Univ.); Eder, Leslie; Lundqvist, Stig. J. Quant. Spectros. Radiative Transfer, 7: 185-202(Jan.-Feb. 1967).

Results are reported of extensive calculations on atomic photoabsorption cross sections by the statistical method in various approximations, based on developments presented in previous papers. A closely spaced family of photoabsorption cross sections emerges which, on scaling with regard to atomic numbers, represents in a unified manner the absorption cross sections of all atoms over wide frequency ranges. A limited search into detailed spectral properties of atoms reveals everywhere some, and in certain instances strong, evidence for collective effects in the response of atoms to external disturbances. (auth)

11421 NEUTRAL ATOM BREMSSTRAHLUNG. Kivel, B. (Avco-Everett Research Lab., Everett, Mass.). Contract AF 29(601)-7055. J. Quant. Spectros. Radiative Transfer, 7: 27-49 (Jan.-Feb. 1967).

Predictions are given for the bremsstrahlung absorption cross section of atomic oxygen and atomic nitrogen. The electron-atom interaction potential energy is adjusted to give agreement with the photoabsorption measurements of the negative oxygen ion. The exchange force is treated in an approximate manner following a suggestion by Slater but adjusted to take account of the dependence on the configuration of the electron wave. The difference in the exchange force for s- and p-waves, as well as the difference between the triplet and quintet configurations in atomic nitrogen, must be preserved to obtain predictions for the bremsstrahlung which are in agreement with experiments. The atomic oxygen absorption cross section is about a factor 5 smaller than that of atomic nitrogen, in agreement with the measurements of Taylor. The Maxwell average atomic nitrogen bremsstrahlung absorption cross section is insensitive to temperature. The atomic nitrogen cross section deviates somewhat from the Kramers wavelength dependence, becoming relatively larger in the blue. (auth)

11422 BREMSSTRAHLUNG IN AIR. Kivel, B. (Avco-Everett Research Lab., Everett, Mass.). Contract AF 29(601)-7055. J. Quant. Spectros. Radiative Transfer, 7: 51-60(Jan.-Feb. 1967).

The partial wave analysis for bremsstrahlung and elastic scattering by molecular nitrogen is reviewed. These studies suggest that the bremsstrahlung in the field of molecular nitrogen can be estimated from the measured momentum transfer cross section. Using this approximation for the molecular components and recent calculations of bremsstrahlung in the field of atomic oxygen and nitrogen, the emissivity and intensity from neutral bremsstrahlung in high-temperature air is estimated. (auth)

11423 UNIFIED SPUTTERING THEORY. Brandt, W.; Laubert, R. (New York Univ.). Nucl. Instrum. Methods, 47: 201-9 (1967).

A simple unified theory of sputtering describes the ablation of random targets by swift heavy particles in terms of the atomic processes triggered by the energy transfer from the impinging particles to the target atoms. A comprehensive sputtering yield curve is derived in an approximate manner, applicable to a wide range of particle-target combinations at particle energies large compared to the atomic displacement energy in the target. The properties and limitations of this yield curve are examined and compared with recent experimental data. (auth)

11424 IONIZATION OF ATOMS BY AN ELECTROMAGNETIC WAVE FIELD. Nikishov, A. I.; Ritus, V. I. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 52: 223-41 (Jan. 1967). (In Russian).

The exact matrix element for ionization of atoms and systems bound by short range and Coulomb forces is represented in a compact form convenient for studying Coulomb forces. The calculation is performed for multiquantum ionization when the matrix element can be reduced to the product of two factors. The most significant of these has the form of a matrix element for a system bound together by short range forces and depends on the Coulomb forces only via the binding energy I. The other factor takes into account the specific effect of the Coulomb forces. When large distances are effective and $\alpha Z/\nu \lesssim 1$ (these conditions are satisfied in the case of ionization by a circular-polarized wave) the Coulomb factor is an exponential function of the first Coulomb correction and increases the ionization probability by $\sim (B_0\xi/B\sqrt{1+\xi^2})^{2\nu}$, where B/B_0 is the field amplitude in atomic units, $\xi = 2IB/\omega B_0$, $\nu = \alpha Zm/\sqrt{2mI}$ (in a pure Coulomb field, that is, for atoms, ν is identical with the principal quantum number). Values $\alpha Z/\nu \sim \sqrt{I/\omega} \gg 1$ are effective for ionization by a linear-polarized wave and this makes quantitative calculations more difficult. A qualitative estimation indicates that in this case Coulomb forces may significantly increase the ionization by $\sim \exp(c\sqrt{I/\omega})$, $c \sim 1$. Removal of the infrared (Coulomb) divergence by a stationary field is also discussed. (auth)

11425 ORIENTATION OF HYDROGEN ATOMS BY RESONANCE RADIATION. Varshalovich, D. A. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz., 52: 242-54 (Jan. 1967). (In Russian).

Spin temperatures characterizing the population of magnetic sublevels of the $1S_{\frac{1}{2}}(F = 0.1)$ state of HI atoms located in a radio wave field $\lambda = 21$ cm and an ultraviolet radiation field $\lambda \sim 1216$ to 912 Å are calculated. The attenuation and amplification coefficients for $\lambda = 21$ cm radio waves traversing a medium consisting of oriented HI atoms are determined. The conditions for appearance of inverse population of the $F = 1$ $(1S_{\frac{1}{2}})$ level are determined. (auth)

11426 GENERAL THEORY OF CAVITY IONISATION. Burlin, T. E. (Polytechnic, London. St. John's Hospital for Diseases of the Skin, London). Brit. J. Radiol., 39: 727-34(Oct. 1966).

The form of a general theory of cavity ionization is outlined. By considering the modification of the shape and the energy in the electron spectrum produced by the cavity material in the medium, a general theory of cavity ionization is derived. It is shown to be in good agreement with experimental results. The application of this general cavity theory to solid and liquid state detectors is discussed. (auth)

11427 EFFECTIVE CROSS SECTIONS FOR EXCITATION OF INTERCOMBINATIONAL TRANSITIONS BY ELECTRON IMPACT. Beigman, I. L.; Vainshtein, L. A. Zh. Eksp. Teor. Fiz., 52: 185-90(Jan. 1967). (In Russian).

A method is proposed for calculating the cross sections for excitation of intercombinational transitions. The method is based on application of orthogonalized wave functions of the external electrons. It is shown that in contrast to the Born–Oppenheimer method the present one is equivalent to the first order in a certain perturbation theory. (auth)

11428 OPTICAL BREMSSTRAHLUNG IN AN ABSORBING MEDIUM. Pafomov, V. E. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 52: 208-17(Jan. 1967). (In Russian).

The angular distribution and degree of polarization of the radiation emitted by an electron impinging on an absorbing dielectric and ferroelectric along the normal to the interface is calculated by taking into account multiple scattering. Averaging of the intensity of the radiation over all possible trajectories is performed by taking into account the relative phase shift of waves emitted from different parts of the trajectory due to scattering. For relativistic particles this phase shift is significant. The results are valid for a thin opaque plate for which the probability for scattering into large angles is small, provided the mean square of the scattering angle over the path of wave absorption in the medium is smaller than unity. (auth)

11429 MEASUREMENT OF THE CROSS SECTIONS FOR IONIZATION BY ELECTRON IMPACT IN SUBSTANCES WITH LOW VAPOR PRESSURE. Pavlov, S. I.; Rakhovskii, V. I.; Fedorova, G. M. Zh. Eksp. Teor. Fiz., 52: 21-8(Jan. 1967). (In Russian).

A method is developed for studying ionization by electron impact in substances with a low vapor pressure. The apparent ionization cross sections for lead, copper and silver are measured at energies from the ionization threshold up to 150 eV. The results of the measurements are in satisfactory agreement with the theoretical estimations. A fine structure on the initial part of the ionization function of lead is found which may be due to auto-ionization processes. (auth)

11430 CROSS SECTION FOR IONIZATION OF GASES BY 1 TO 3 MeV PROTONS. Pivovar, L. I.; Levchenko, Yu. Z. Zh. Eksp. Teor. Fiz., 52: 42-8(Jan. 1967). (In Russian).

The total cross section for ionization of the gases H_2, N_2, He, Ne, Ar and Kr by protons with energies between 1 to 3 MeV are measured. The results are compared with the experimental data on ionization of gases by fast protons and electrons. The results are also compared with the predictions of the classical inelastic collision theory and with the calculations based on the first Born approximation. (auth)

11431 MEASUREMENT OF THE π^- MESON CASCADE TIME IN GASEOUS ^{3}He. Zaimidoroga, O. A.; Sulyaev, R. M.; Tsupko-Sitnikov, V. M. Zh. Eksp. Teor. Fiz., 52: 97-9(Jan. 1967). (In Russian).

The cascade time of negative pions in gaseous ^{3}He is measured by using a diffusion chamber in a magnetic field. The value obtained is $(1.4 \pm 0.7) \times 10^{-10}$ sec which is the same as the value obtained in liquid helium. (auth)

11432 ON APPLICABILITY OF THE BORN APPROXIMATION TO THE PROBLEM OF COLLISIONS BETWEEN ELECTRONS AND EXCITED ATOMS. Starostin, A. N. Zh. Eksp. Teor. Fiz., 52: 124-35(Jan. 1967). (In Russian).

The problem of the limits of applicability of the first approximation of perturbation theory for calculation of the cross section for electron scattering by excited atoms is considered. Conditions of validity of the Born approximation for elastic and inelastic collisions between electrons and excited atoms are formulated on basis of the condition of smallness of the second-order amplitude in perturbation theory. (auth)

11433 FOCUSING OF AN ELECTRON BEAM FROM A LOW-NOISE GUN WITH DIFFERENT MAGNET SYSTEMS. PART IV. TRAJECTORIES OF THE OUTERMOST ELECTRON IN A BEAM FOCUSED BY A PERIODIC PERMANENT MAGNET. Chen, Tsung-shan (RCA, Harrison, N. J.). Int. J. Electron., 21: 105-35(Aug. 1966).

The traces described by the outermost electron in a beam produced by a magnetically immersed electron gun and focused by a periodic permanent magnet in the drift region are described. The beam profiles were computed by use of a fast computer for three types of magnetic flux density distribution in the transition interval between the gun and the drift regions. In the first series of solutions, the uniform magnetic field over the gun region connects directly with the rising part of the sinusoidally varying magnetic field. With the period of the alternating flux held constant, proper and improper flux densities in the gun and helix regions produce, respectively, acceptable or runaway electron beams. In the second series of computations, a compensating field in the form of a dent is introduced over the intervening space between the gun and drift regions. Variations are made in the magnitude of the gun field and amplitude and period of the alternating field. Satisfactory profiles are obtained when these parameters have optimum values; incompatibility between high flux densities and large period of the magnets is indicated by the ever-growing beam ripples. In the third

series, beam profiles are computed for the cases when optimum spatial period of the magnet is used and the magnitudes of flux densities in the gun, transition, and helix regions are altered. Very high gun fields are not conducive to producing good electron transmission, while judicious choice of compensating field leads to smooth beams even with comparatively low flux densities in both the gun and helix regions. (auth)

11434 HIGHLY EFFECTIVE IONIZER FOR A POLARIZED ION SOURCE. Slabospitskii, R. P.; Karnaukhov, I. M. Ukr. Fiz. Zh., 11: 1252-3(Nov. 1966). (In Ukrainian).

An annular cathode with an opening is used for injection of the atom beam into the region of ionization. The electrons emitted by the annular electrode are formed into a continuous cylindrical beam. A three-electrode electron gun is used in order to obtain maximum electron current from the cathode with optimum ionization of the atom beam. The maximum electron current is given by the equation: $I_{max} = 25.4 \times 10^{-6} V^{1.5}$. Here V is the potential of the secondary anode. The ionization of the atom beam is carried out in a strong homogeneous magnetic field. The optimum magnetic field is given as follows: $B_0 = 830 (I_{max}^{0.5}/V^{0.25} r_0)$. Here r_0 is the radius of the electron beam. If the potential of the secondary electrode is 400 volts and the potential of the electron collector is 300 volts, the value of I_{max} is equal to 200 mA, and with $r_0 = 0.3$ cm, B = 270 gauss. The electron current can actually be twice as great due to compensation of the electron space charge by the ions. The magnetic field must also be a factor of two to three greater. An expression is given for the ion current. Polarized beams with a current strength of ~10 μA can be expected. Thus, the intensity of a polarized beam can be increased manyfold with a few modifications of present sources of polarized ions. (TTT)

11435 CLASSICAL MOTION OF A CHARGED PARTICLE IN A MONOCHROMATIC PLANE WAVE. Sanderson, J. J. (English Electric Co., Ltd., Whetstone, Eng.). Int. J. Electron., 21: 173-82(Aug. 1966).

The classical motion of a charged particle in an approximately monochromatic plane wave is determined by solving the Lorentz-Dirac equation. The method of solution treats the Abraham four-vector as a small perturbation to the relativistic Lorentz equation. The significant corrections to the zero-order solution are the secular terms which arise in a perturbation solution. (auth)

11436 QUASI ELASTIC SCATTERING OF SLOW NEUTRONS BY WATER AND AN AQUEOUS SOLUTION OF SODIUM CHLORIDE. Goland, A. N.; Otnes, K. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 153: 184-7(Jan. 5, 1967). (BNL-10491).

Using chopper time-of-flight techniques and a beryllium-filtered incident spectrum, the quasi-elastic scattering of neutrons by water and by a 4N solution of NaCl was examined at a scattering angle of 90°. After subtracting an inelastic component attributed to scattering by a gas of mass-18 particles, we completed our analysis in terms of the continuous-diffusion model of neutron scattering by fitting a Lorenztian-broadened incident spectrum to the corrected data. In this way the self-diffusion coefficient D of water in each sample was determined. The two values obtained are 2.2×10^{-5} cm²/sec and 1.7×10^{-5} cm²/sec for pure water and for the salt solution, respectively. These values are in good agreement with NMR and radiotracer measurements. When considered in the light of current theories of water structure and hydration, they lead one to the conclusion that the quasi-elastic peak in the neutron spectrum of water arises primarily from the diffusive motion of individual water molecules. (auth)

11437 HYLLERAAS VARIATIONAL CALCULATION OF AUTO-IONIZATION STATES. Bhatia, A. K. (Goddard Space Flight Center, Greenbelt, Md.); Temkin, A.; Perkins, J. F. Phys. Rev., 153: 177-81(Jan. 5, 1967).

Auto-ionization states of two-electron systems (H^- and He) have been calculated using the Feshbach Q-projection-operator formalism with a Hylleraas-type variational wave function. Results for most of the S states in He and the first two in H^- are lower than any previously calculated. The energy of the lowest ^1S state in He is found to be −1.5575487 Ry using 50 terms, and the convergence indicates that the first 6 figures are significant. Except for the lowest ^3P state in He, calculations of odd-parity P states do not yield as low results as previous relative partial-wave calculations. Comparison with accurate resonant-energy calculations of Burke and Taylor in S states allows us to deduce energy shifts which are inherent in the projection-operator technique. (auth)

11438 POLARIZATION OF LIGHT FROM e^-–He COLLISIONS. Soltysik, Edward A.; Fournier, Albert Y.; Gray, Robert L. (Univ. of Massachusetts, Amherst). Phys. Rev., 153: 152-6(Jan. 5, 1967).

The polarization of light resulting from the excitation of helium by electron impact has been measured as a function of electron energy. Results are reported in the energy threshold region for the following transitions: $3^1P \rightarrow 2^1S$ (λ = 5016 Å), $3^3P \rightarrow 2^3S$ (λ = 3889 Å), and $4^1D \rightarrow 2^1P$ (λ = 4922 Å). The results reported here are in substantial agreement with the results previously reported by McFarland. Also, no dependence of the polarization on the magnetic field parallel to the electron beam was observed. (auth)

11439 SINGLE ELECTRON CAPTURE AND LOSS CROSS SECTIONS FOR 2- TO 50-keV HYDROGEN ATOMS INCIDENT UPON HYDROGEN AND THE INERT GASES. Williams, J. F. (Australian National Univ., Canberra). Phys. Rev., 153: 116-20 (Jan. 5, 1967).

The single-electron capture and loss cross sections $\sigma_{0,-1}$ and σ_{01} for 2 to 50-keV hydrogen atoms incident upon hydrogen molecules and inert-gas atoms have been measured directly by observing the growth of the fast-collision products (i.e., the fast primary H_1^0 which have changed charge) with the target-gas number density. In H_2, He, Ne, and Ar, the present values of $\sigma_{0,-1}$ and σ_{01} generally confirm previous measurements, with the notable exception that in H_2 the low-energy values of σ_{01} are as much as 30% smaller (at 2 keV) than the values of McClure. In Kr and Xe there are no previous measurements of $\sigma_{0,-1}$, while the only previously reported values of σ_{01} are smaller than the present values by as much as a factor of 3. For a hydrogen-gas target, the present measurements do not show any large subsidiary peaks. The use of an electrostatic field, prior to the collision cell, to quench possible excited states in the primary H_1^0 atom beam is shown to have only a very small effect upon the measured cross sections. Both σ_{01} and $\sigma_{0,-1}$ are found to increase in value with increasing atomic number for all the inert gases. The low-energy (adiabatic) region is extended down to 2 keV, where it is seen that σ_{01} rises exponentially with increasing relative velocity of the colliding particles. (auth)

11440 FINE AND HYPERFINE STRUCTURE OF THE $2\,^2P$ TERM OF ^{6}Li AND ^{7}Li. Brog, K. C.; Eck, T. G.; Wieder, H. (Case Inst. of Tech., Cleveland). Phys. Rev., 153: 91-103 (Jan. 5, 1967).

Interference signals in resonance fluorescence associated with the crossing of the $J = 3/2$, $m_J = -3/2$ and $J = 1/2$, $m_J = 1/2$ fine-structure Zeeman levels were used to investigate the fine and hyperfine structure of the 2^2P term of ^{6}Li and ^{7}Li. The magnetic field strength corresponding to this crossing was determined for each isotope to within 1 part in 4.5×10^4. However, the precision with which the fine-structure splitting can be inferred from the crossing field is limited at the present time by a lack of knowledge of relativistic and diamagnetic corrections to the orbital g factor g_L. The ^{7}Li signal exhibited well-resolved hyperfine structure. Measurements of this structure have been used together with Ritter's result for the hyperfine splitting in the $2^2P_{\frac{1}{2}}$ state to obtain values for $a_{c,\frac{1}{2}}$ and $a_{d,\frac{1}{2}}$, the Fermi contact and dipole–dipole contributions to the magnetic hyperfine interaction in the $2^2P_{\frac{1}{2}}$ state of ^{7}Li, and a value for Q, the quadrupole moment of the ^{7}Li nucleus. They are: $a_{c,\frac{1}{2}} = -10.53 \pm 0.23$ Mc, $a_{d,\frac{1}{2}} = 7.13 \pm 0.03$ Mc, and $Q = (-3 \pm 2) \times 10^{-26}$ cm². The widths of the hyperfine components of the ^{7}Li crossing signal yield $(2.72 \pm 0.04) \times 10^{-8}$ sec for the lifetime of the 2^2P term of atomic lithium. (auth)

11441 VARIATIONAL LOWER BOUNDS ON ELECTRON–HYDROGEN s-WAVE PHASE SHIFTS. Aronson, I.; Hahn, Yukap; Henry, Paul M.; Kleinman, Chemia J.; Spruch, Larry (New York Univ., N. Y.). Phys. Rev., 153: 73-80(Jan. 5, 1967).

The variational-bound (or minimum-principle) formulation for single-channel scattering was applied to the calculation of rigorous lower bounds on the s-wave phase shifts for the scattering of electrons by hydrogen atoms (e^-H) for energies below the excitation threshold. This method was previously applied to positron-hydrogen (e^+H) elastic scattering. Because of the exchange effect in the e^-H case, a projection operator is employed which projects out of the wave function those states in which either or both of the electrons are in the ground state. The method requires the exact solution of the static equation, and of the corresponding static Green's function G^P, which is expressed in terms of the solution of an integral equation. Trial functions are chosen which are symmetrized (or antisymmetrized) and correspond to states of the hydrogen atom of given angular momentum quantum number l; the associated radial functions contain nonlinear variational parameters. The e^-H calculations are found to give much more accurate results for a given number of parameters than the e^+H calculations. (auth)

11442 COINCIDENCE MEASUREMENTS OF Ne^+–Ne COLLISIONS. Kessel, Quentin C.; McCaughey, Michael P.; Everhart, Edgar (Univ. of Connecticut, Storrs). Phys. Rev., 153: 57-61 (Jan. 5, 1967).

A study is made of single collisions of keV-energy Ne ions with Ne atoms wherein both particles scattered from the same en-

counter are detected in coincidence. The charge states m of the scattered incident particle and n of the recoiling target particle are determined. The relative probability of the (m,n) reaction and the associated inelastic energy loss are measured as to their dependence upon the scattering angles and the incident energy T_0. The statistical model proposed by Everhart and Kessel is used to analyze the data. At the higher energies (T_0 from 150 to 400 keV), a double structure is found in the values of inelastic energy loss. This structure is attributed to a K-shell vacancy found with low probability in some of the neon particles after the collision. The expected Auger electrons are detected and found to have 750-eV energy. (auth)

11443 MULTICHANNEL PHOTO-IONIZATION OF ATOMIC SYSTEMS. Henry, R. J. W. (Goddard Space Flight Center, Greenbelt, Md.); Lipsky, Lester. Phys. Rev., 153: 51-6(Jan. 5, 1967).

Expressions for multichannel photoionization are obtained with the dipole approximation assuming LS coupling; while including the effects of coupling between channels, these expressions give separate contributions for each channel. The explicit form of the cross sections for atomic systems with configurations $1s^22s^22p^q$ is obtained, assuming superpositions of determinantal wave functions (Hartree–Fock) for initial and final states. The effects of core relaxation are considered. The formalism is applied to the photoionization of neon, with the result that coupling between channels and core relaxation have a larger effect on the individual channel cross sections thatn on the total cross section. Both effects tend to bring the dipole velocity and length forms of the cross section into closer agreement with each other, but the improvement is appreciable only near threshold. (auth)

11444 DIFFERENTIAL CHARGE-TRANSFER CROSS SECTION FOR COLLISIONS OF H^+ ON O_2. Fleischmann, Hans H.; Young, Robin A.; McGowan, J. William (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Rev., 153: 19-22(Jan. 5, 1967).

The angular distribution of fast hydrogen atoms from the exothermic reaction $H^+ + O_2 \rightarrow H + O_2^+$ is measured for proton energies of 30 to 300 eV and scattering angles of 0 to 30°. By means of the known total cross section for this reaction, absolute differential cross sections are also derived. In spite of the relatively large energy defect of 1.5 eV, the distributions are found to be highly peaked in the forward direction. Theoretical implications of this result are discussed qualitatively. Measurements of the differential charge-exchange cross section of the system He^+ + He showed good agreement with theoretical expectations. (auth)

11445 CHARGE EQUILIBRIUM OF HELIUM IONS IN HELIUM GAS FROM 60 TO 840 keV. Meckbach, W.; Nemirovsky, I. B. (Comision Nacional de Energia Atomica, Bariloche, Argentina. Univ. Nacional De Cuyo, Bariloche, Argentina). Phys. Rev., 153: 13-18(Jan. 5, 1967).

Charge equilibrium fractions corresponding to the components $(He)^0$, $(He)^+$, and $(He)^{2+}$ of a helium beam in helium gas have been measured. Singly ionized beams of ^4He and doubly ionized beams of ^3He were used. Ion velocities covered the range corresponding to energies of $(^4He)^+$ ions from 60 to 840 keV. The charge-equilibrated beam was magnetically separated and charge spectra were recorded by means of a movable detector of equal sensitivity for all three charge components. In the energy interval where they overlap, namely between 60 and 200 keV, the measured equilibrium fractions are in excellent agreement with those of Barnett and Stier. No systematic discrepancy between the equilibrium fractions obtained at equal velocities with beams of the isotopes ^3He and ^4He was observed. The results were discussed in terms of the probabilities M_I for presence of any one of the two electrons in $(He)^0$ and M_{II} for presence of the one electron in $(He)^+$ as a function of the beam velocity v. Similarity of the curves for M_I and M_{II} allows for their superposition by a translation transformation on the velocity scale by a constant approximately equal to the "orbital" velocity u_I of either electron in $(He)^0$ as calculated from its first ionization energy. This is in disagreement with Dmitriev's assumption that the presence probabilities M_i can be described by a universal function $M(v/u_i)$. (auth)

11446 EFFECT OF IMPRISONMENT OF RADIATION IN SODIUM VAPOR ON THE MEASURED LIFETIME OF THE $3\,^2P$ STATES. Kibble, B. P.; Copley, G.; Krause, L. (Univ. of Windsor, Ont.). Phys. Rev., 153: 9-12(Jan. 5, 1967).

The effect of imprisonment of radiation in sodium vapor on the measured lifetime of the $3\,^2P$ states has been investigated in an experiment in which the atoms in the vapor were excited with 10-nsec pulses of resonance radiation and the elapsed times between the exciting and the fluorescent pulses were recorded using a time-to-amplitude converter and kicksorter. At vapor densities below 10^{10} atoms/cm^3, where there is no multiple scattering, the measured lifetime reaches a constant value of $(1.63 \pm 0.04) \times 10^{-8}$ sec, equal to the natural lifetime of the $3\,^2P$ states. In the density range 10^9 to 10^{13} atoms/cm^3, the variation of the effective lifetime with the vapor density is in good agreement with the predictions of Milne's theory of radiation trapping; agreement with Holstein's theory is observed only in the range 10^{12} to 10^{13} atoms/cm^3. The results of a subsidiary Hanle experiment show that a multiply scattered photon of sodium resonance fluorescence loses its original polarization and that, at high sodium vapor pressure, coherence is not preserved. (auth)

11447 THEORY OF THREE-PHOTON IONIZATION OF THE ALKALI ATOMS. Bebb, H. Barry (Univ. of Rochester, N. Y.). Phys. Rev., 153: 23-8(Jan. 5, 1967).

Three-photon ionization transition rates are calculated for the alkali atoms (except Li) using quantum defect Coulomb functions to evaluate the well-known perturbation formula. Several corrections of previous work are mentioned. The often-used approximation of keeping only a small number of intermediate states is investigated. The predicted three-photon ionization rate (in cgs units) of the alkalis for the ruby photon energy of 1.78 eV is of the order of $10^{-77} \times (\text{photon flux})^3$. Detailed results are presented as dispersion curves of the transition rate for photon energies between the three-photon and two-photon thresholds. (auth)

11448 ELECTRON PHOTODETACHMENT FROM O^- AND ELASTIC SCATTERING FROM ATOMIC OXYGEN. Garrett, W. R. (Univ. of Alabama, Huntsville); Jackson, H. T. Jr. Phys. Rev., 153: 28-35(Jan. 5, 1967).

Cross sections have been determined for the photodetachment of an electron from the negative atomic-oxygen ion. Calculations are made for the three transitions $O^-\,^2P$ to $O\,^3P$, $O\,^1D$, and $O\,^1S$ with photon energies from threshold to 13.6 eV. A method is used wherein wave functions for both bound-state and continuum electrons are obtained through a modified version of Slater's approximation to the Hartree–Fock equations. Correlation effects are included through a polarization potential obtained from an application of first-order perturbation theory to the Hartree–Fock atomic system. Results are compared with the experiments of Smith and of Branscomb, Smith, and Tisone, giving very good low-energy agreement. In addition, the elastic-scattering cross section for neutral oxygen, the dipole polarizability, the attachment cross section, and attachment coefficient for electron capture were also determined. Agreement is quite good between these observables and available experimental data. (auth)

11449 DISSOCIATION OF H_2^+ IONS IN COLLISION WITH H ATOMS: 3 TO 115 keV. McClure, G. W. (Sandia Lab., Albuquerque, N. Mex.). Phys. Rev., 153: 182-3(Jan. 5, 1967).

The cross section for the production of fast protons in collisions between H_2^+ ions and H atoms has been measured in the energy range 3 to 115 keV. The cross section for the same process with H_2 as the target particle was also measured and results were compared with previous work as a test of the calibration method. The results show that the H-atom target is more effective in dissociating H_2^+ than in the larger H_2 molecule in the energy range 10 to 42 keV. This order of effectiveness is reversed below 10 keV and above 42 keV. Comparison of the H-target results with theoretical calculations based on the Born approximation shows that the collisional excitation of the lowest excited state of the H_2^+ ion—the $2p\sigma_u$ state—contributes a minor fraction of the total fast-proton production at 115 keV and a major fraction of 3 keV. The differential angular distributions of the fast protons were found to be the same for the H and H_2 targets at 10 keV. (auth)

11450 SPIN-EXCHANGE CROSS SECTIONS FOR ^{87}Rb–^{87}Rb AND ^{87}Rb–^{133}Cs COLLISIONS. Gibbs, Hyatt M.; Hull, Robert J. (Univ. of California, Berkeley). Phys. Rev., 153: 132-51(Jan. 5, 1967). (UCRL-16785).

In a hyperfine-optical-pumping experiment the Franzen transient method was used to determine the total spin-exchange cross sections for $^{87}Rb-^{87}Rb$ and $^{87}Rb-^{133}Cs$ collisions at 78°C. Values determined in this way were: $\sigma(^{87}Rb-^{87}Rb) = (1.9 \pm 0.2) \times 10^{-14}$ cm^2 and $\sigma(^{87}Rb-^{133}Cs) = (2.3 \pm 0.2) \times 10^{-14}$ cm^2. A large difference between the ground-state hyperfine populations was established by pumping with light absorbable by atoms in only one hyperfine level. In the presence of a second unpumped species, the resulting polarization relaxed with a characteristic rate of $1/\tau = 1/T + 1/T_{S1} + 1/T_{E1}$, where T is the non-spin-exchange relaxation time and T_{S1} and T_{E1} are the self- and cross-exchange times. Then τ was obtained by fitting the signal to a single exponential and applying a small correction ($\approx 10\%$) to account for the fact that the signal is only approximately proportional to the polarization (and hence to a single exponential). The relaxation measurement utilized rapid data accumulation with a Kerr-cell shutter and pulse-height analyzer. The cross section can be easily deduced from the relaxa-

tion times if the corresponding densities are known. Each density was measured by determining the integral over all frequencies of the absorption coefficient by means of a scanning Fabry–Perot interferometer. (auth)

11451 SUBMILLIMETER CHERENKOV RADIATION FROM A DC ELECTRON BEAM. Ulrich, Reinhard (Univ., Freiburg i. B.). Z. Phys., 199: 171-86(1967).

A dc electron beam is shot at a low distance parallel to the plane surface of a dielectric. The Cherenkov radiation produced in the dielectric is observed. It has a continuous spectrum which was determined interferometrically in the 0.6 to .3 mm wavelength region. The measured dependences on beam voltage, current, and distance agree with theory within the experimental errors. The produced absolute spectral intensities were of the order of 10^{-19} watt/cps. (auth)

11452 PERTURBED HYDROGEN ATOM AS AN EXAMPLE OF BROKEN SYMMETRY. Gunson, J. Russell (Univ. of Durham, Eng.). Nucl. Phys., 87: 775-84(1967).

The methods of Fubini et al. are applied to the hydrogen atom perturbed by a central potential as a potential model of a broken symmetry. The model pinpoints the reasons why intermultiplet splitting cannot be determined absolutely, and using the same information it is seen that perturbation theory also fails. In the appendix, the splitting in the second energy multiplet is calculated by conventional and commutator methods, and the results are shown to agree. (auth)

11453 TECHNOLOGY AND POSSIBLE APPLICATIONS OF ELECTROSTATIC ION PROPULSION SYSTEMS. II. Au, G. F. (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Institut fuer Strahlantriebe, Brunswick). Explosivstoffe, 13: 90-6 (Apr. 1965). (In German).

A discussion is presented on electron-bombardment ion thrusters and electrostatic accelerators. The geometry of accelerator electrodes is examined. Electrode erosion as a function of lifetime and operating conditions and a method for minimizing electrode loss are discussed. The optimum composition for electrodes in ion thrusters is considered and it is found that copper is a suitable metal for electrodes in tungsten ion generators. (Int. Aero. Abstr.)

11454 TECHNOLOGY AND POSSIBLE APPLICATIONS OF ELECTROSTATIC ION PROPULSION SYSTEMS. VI. Au, G. F. (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Institut fuer Strahlantriebe, Brunswick). Explosivstoffe, 13: 342-8 (Dec. 1965). (In German).

A discussion is presented of technical problems relating to electrostatic ion drives in the light of present-day technological capabilities. Two types of gaseous discharge ion sources, the duoplasmatron and the electron-bombardment ion generator, are described. The geometry of accelerator configuration and the reduction of electrode loss are shown to be determining parameters. (auth)

11455 INFLUENCE OF THE THERMAL VIBRATIONS OF THE CRYSTAL LATTICE UPON THE ENERGY DISTRIBUTION OF SCATTERED IONS. Mashkova, E. S.; Molchanov, V. A.; Soshka, V. (Moscow State Univ.). Phys. Status Solidi, 19: 425-8(Jan. 1, 1967).

The effect of thermal lattice vibrations on the energy spectra of ions scattered by a Ni crystal was studied. The intensities of the double-scattering peaks were found to decrease with an increase in the target temperature. (auth)

11456 DEPENDENCE OF THE ION–ELECTRON EMISSION COEFFICIENT ON THE ANGLE OF INCIDENCE. Evdokimov, I. N.; Mashkova, E. S.; Molchanov, V. A.; Odintsov, D. D. (Moscow State Univ.). Phys. Status Solidi, 19: 407-15(Jan. 1, 1967).

The dependence of the ion–electron emission coefficient on the angle of incidence is studied for targets of polycrystalline metals (Cu, Ag, Mo, Zr, W, Bi) and a graphite target bombarded with 25- to 30-keV noble gas and nitrogen ions. The application of a magnetic field parallel to the axis of rotation shows that both the positive and negative ion currents to the collector are negligibly small. The emission coefficient increases as the angle of incidence increases up to angles of about 80 to 85°. Up to a certain limiting angle (from 36 to 81° for different ion–target combinations) the angular dependence may be approximated by a reciprocal cosine law, while for larger angles the variation is rather slower. Comparisons are made with calculations based on the transparency model. (auth)

11457 REEVALUATION OF X-RAY ATOMIC ENERGY LEVELS. Bearden, J. A.; Burr, A. F. (Johns Hopkins Univ., Baltimore). Rev. Mod. Phys., 39: 125-42(Jan. 1967).

All of the x-ray emission wavelengths have recently been re-evaluated and placed on a consistent Å* scale. For most elements these data give a highly overdetermined set of equations for energy level differences, which have been solved by least-squares adjustment for each case. This procedure makes "best" use of all x-ray wavelength data, and also permits calculation of the probable error for each energy difference. Photoelectron measurements of absolute energy levels are more precise than x-ray absorption edge data. These have been used to establish the absolute scale for eighty-one elements and, in many cases, to provide additional energy level difference data. The x-ray absorption wavelengths were used for eight elements and ionization measurements for two; the remaining five were interpolated by a Moseley diagram involving the output values of energy levels from adjacent elements. Probable errors are listed on an absolute energy basis. In the original source of the present data, a table of energy levels in Rydberg units is given. Difference tables in volts, Rydbergs, and milli-Å* wavelength units, with the respective probable errors, are also included there. (auth)

11458 X-RAY WAVELENGTHS. Bearden, J. A. (Johns Hopkins Univ., Baltimore). Rev. Mod. Phys., 39: 78-124(Jan. 1967).

Inconsistencies in accepted values (in x units) of x-ray reference lines have recently been demonstrated, although all are supposedly based on "good" calcite crystals. Factors supporting the selection of the W $K\alpha_1$ line as the X-Ray Wavelength Standard are critically discussed. A review is given of the experimental measurements which are used to establish the wavelength of this line on an absolute angstrom basis. Its value is λ W $K\alpha_1$ = (0.2090100 ± 5 ppM) Å. This may be used to define a new unit, denoted by Å*, such that the W $K\alpha_1$ wavelength is exactly 0.2090100 Å*; hence 1Å* = 1Å ± 5 ppM. The wavelengths of the Ag $K\alpha_1$, Mo $K\alpha_1$, Cu $K\alpha_1$, and the Cr $K\alpha_2$ have been established as secondary standards with probable error of approximately one part per million. Sixty-one additional x-ray lines have been used as reference values in a comprehensive review and reevaluation of more than 2700 emission and absorption wavelengths. The recommended wavelength values are listed in Å* units together with probable errors; corresponding energies are given in keV. A second table lists the wavelengths in numerical order, and likewise includes their energies in keV. (auth)

11459 RESONANT SCATTERING OF ELECTRONS BY ATOMIC SYSTEMS. Smith, Kenneth (Royal Holloway Coll., Englefield Green, Eng. Atlas Computer Lab., Didcot, Eng.). Rep. Progr. Phys., 29: 373-443(1966).

The resonant scattering of electrons by atomic systems and its interrelation with the phenomenon of autoionization is reviewed both theoretically and experimentally. The Siegert definition of a resonance has been used to illustrate the connection underlying the various theoretical models. Particular attention has been given to the close-coupling approximation and the related effective-range theories, as well as to the formalism of Feshbach projection operators and Fano's theory of configuration interaction. (auth)

11460 TABLES OF PHYSICAL AND CHEMICAL CONSTANTS AND SOME MATHEMATICAL FUNCTIONS (Thirteenth Edition). Kaye, G. W. C.; Laby, T. H. New York, John Wiley and Sons, Inc., 1967. 255p. $5.75.

11461 CONFIGURATION INTERACTION CALCULATIONS OF REPULSION BETWEEN TWO NORMAL HELIUM ATOMS AND QUADRUPOLE MOMENT OF THE ^{7}Li NUCLEUS. Morris, Billy Mack. Knoxville, Tenn., Univ. of Tennessee, 1966. 179p.

Thesis.

The repulsion between two normal helium atoms at close separation has been calculated using the united atom or one-center method with configuration interaction. The object of the calculation was to determine the effectiveness of the one-center method as a substitute for the more accurate but more difficult two-center method. The electron configurations used to construct the trial wave function of symmetry type $^1\Sigma_g^+$ were $1s^2 2p\sigma^2$, $1s3d\sigma 2p\sigma^2$, $ns^2 2p\sigma^2$, $1s5g\sigma 2p\sigma^2$, $1s^2 2s^2$, $1s3d\sigma 2s^2$, and $1s^2 2s3d\sigma$. Separate variational screening parameters were assigned to each orbital in each configuration, and the principal quantum number for the ns orbital was varied over small integral values. The best He_2 repulsion energy obtained at R = 1.0 atomic units was for the mixture $1s^2 sp\sigma^2$ + $1s3d\sigma 2p\sigma^2$ + $ns^2 2p\sigma^2$, but this result is about 9 electron volts above that of the best two-center calculation. It is concluded that the one-center method for He_2 can be made competitive with the two-center method (LCAO-MO) only at the expense of greater computational effort than the accuracy of such calculations warrants. The quadrupole moment of the ^{7}Li nucleus has been calculated using the Wigner supermultiplet theory with configuration interaction. The configurations considered were $1s^4 1p^3$,

$1s^4 1p^2 2p$, $1s^4 1p^2 1f$, $1s^4 1p^2 3p$, and $1s^3 1d 1p^3$. A similar earlier calculation which did not include the last two configurations obtained the correct experimental quadrupole moment Q, but the amount of configuration mixing required was large. (The amplitude of the $1s^4 1p^3$ function was only 0.60.) The present calculation involved the construction of all independent $^{22}P_{\frac{1}{2}}$[4,3] functions for the new configurations, the evaluation of matrix elements of the quadrupole moment operator, and the selection of configuration mixing coefficients to fit the experimental value of Q. It was found that any number of sets of mixing coefficients could give the correct experimental Q, but much larger amplitudes of the lowest energy configuration, $1s^4 1p^3$, were possible because of the inclusion of the core-excited configuration $1s^3 1d 1p^3$. (Dissertation Abstr.)

Cosmic Radiation

Refer also to abstracts 10611, 10612, 10617, 11380, 11382, 11507, and 11738.

11462 (N-66-26644) OBSERVATION OF THE ELEMENTAL ABUNDANCES IN LOW-ENERGY COSMIC RAYS IN JULY 1964. Fichtel, C. E.; Reames, D. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Apr. 1966. 22p. (NASA-TM-X-55476; X-611-66-138). CFSTI $3.00 cy, $0.65 mn.

In a sounding rocket experiment, nuclear emulsion detectors were used to study the composition and fluxes of primary cosmic-ray nuclei with charge $Z \geq 3$ above the atmosphere in the region of kinetic energy from 40 to 220 MeV/nucleon. The results show a light ($3 \leq Z \leq 5$) to medium ($6 \leq Z \leq 9$) flux ratio of .16 ± .07 in the 40 to 100 MeV/nucleon region and a heavy ($Z \geq 10$) to medium ratio of .42 ± .11 in the 70 to 160 MeV/nucleon interval. The elemental structure of the medium nuclei is found to contain (40 ± 7)% carbon, [10(+4/−6)]% nitrogen and (48 ± 7)% oxygen. Extrapolating the fluxes back through approximately 2.5 g/cm^2 of interstellar hydrogen to the source, one finds a flux of nitrogen consistent with zero. (auth)

11463 (JPRS-38794) INVESTIGATION OF COSMIC RADIATION BY THE ARTIFICIAL SATELLITE "LUNA-10." Grigorov, N. L.; Maduev, V. L.; Pisarenko, N. F.; Savenko, I. A. Translated from Dokl. Akad. Nauk SSSR, 170: 565-6(1966). 3p. (TT-66-35218). CFSTI $3.00 cy, $0.65 mn.

Instrumentation for the investigation of cosmic radiation on artificial lunar satellite, Luna-10, is described. Observations of the total level of cosmic radiation in free interplanetary space were made in the period from March 31 to April 3, 1966. The mean counting rate of the hard cosmic particles by a shielded counter was 12.2 ± 0.1 sec^{-1}. The value of the flux of primary cosmic radiation indicates that despite the increase of solar activity which began in 1966 the intensity of primary radiation continues to maintain a high value, characteristic of the period of the minimum of solar activity. On April 3, 1966, the satellite was put into a selenocentric orbit with an angle of inclination of 72° to the lunar axis of rotation. It was possible to determine the dependence of the counting rate of a shielded counter on altitude above the lunar surface. This dependence is shown. (J.H.M.)

11464 NUCLEAR PROCESSES IN COMETS. Greenstein, Jesse L. (Carnegie Institution of Washington, Washington, D. C. California Inst. of Tech., Pasadena). Mem. Soc. Roy. Sci. Liege, 12: 483-8(1966).

A study is presented of comets when they are subject to the same cosmic-ray bombardment as interstellar material, to kilovolt collisions with solar-wind protons near perihelion, and to solar flare, solar cosmic-ray, 100 MeV-events, also mostly near perihelion. The questions of how much this bombardment evaporates or alters the surface characteristics of the solids and of how much nuclear transmutation is induced are treated. The presence of spallation products and isotope abundance changes is investigated. Other questions treated include what nucleosynthetic effects are produced by the higher energy particles and what the expected reaction products are. In conclusion, an estimate of the yields at the present low level of cosmic-ray bombardment is given. (Int. Aerospace Abstr.)

11465 MOMENTA OF MUONS IN EXTENSIVE AIR SHOWERS. Earnshaw, J. C.; Orford, K. J.; Rochester, G. D.; Somogyi, A. J.; Turver, K. E.; Walton, A. B. (Univ. of Durham, Eng.). Proc. Phys. Soc. (London), 90: 91-108(Jan. 1967).

A magnet spectrograph, with visual detectors, and arrays of diffused-light Cherenkov detectors at the Haverah Park Cosmic Ray Station have been used to determine the momenta, the signs, and the densities of muons in large extensive air showers. The observational data cover the momentum range 1-100 GeV/c, and refer to muons at distances of 10 to 800 m from the cores of showers of size 10^5 to 10^8 particles. The measurements are used to compute the spectra by a method which involves only very broad assumptions about the shape of the spectra. The spectra are presented in the form of the integral and differential muon densities as functions of momentum and core distance. The results are compared with the magnet spectrograph measurements of Bennett and Greisen, and good agreement is found where the data are comparable. The empirical relation suggested by Greisen fits the present results well, but the absolute number of muons given by the relation is rather smaller than found here. Comparison is also made with other types of experiment and fair agreement is found in certain cases. An attempt is made to check the preliminary predictions of recent theoretical models of the nuclear cascade by Hillas and Holyoak et al. Some agreement is found, but both of these theories predict too few high-energy muons at large distances from the core. A theoretical interpretation by Khrenov of experimental data on the lateral distribution of muons also predicts muon densities at large distances from the core which are much lower than found here. (auth)

11466 PROTON SPACE STATIONS AND FIRST RESULTS OBTAINED BY THEM. Grigorov, N.; Savenko, I.; Skuridin, G. (Academy of Sciences, Moscow). COSPAR (Comm. Space Res.) Inform. Bull., No. 31, 25-31(Apr. 1966).

An analysis is made of the Soviet Proton 1 and Proton 2 space stations, which are equipped with ionization calorimeters to study cosmic ray particles of high and ultrahigh energies. A spectrometer of charges for investigating cosmic rays with energies below 30 BeV is described, and special gamma telescopes which both satellites carry to investigate high-energy electromagnetic radiation (gamma quanta) are discussed. Preliminary analysis of the energy spectrum of primary cosmic rays from data obtained on Proton 1 shows that concepts based on earlier indirect data are not confirmed by direct measurements. (Int. Aero. Abstr.)

11467 REPORTED COSMIC GAMMA-RAY SOURCE IN CYGNUS. Frye, Glenn M. Jr.; Wang, Chia Ping (Case Inst. of Tech., Cleveland). Phys. Rev. Lett., 18: 132-4(Jan. 23, 1967).

Recently Duthie, Cobb, and Stewart have presented evidence for a source of cosmic gamma rays at 304° right ascension and +35° declination with an intensity of $(1.5 \pm 0.8) \times 10^{-4}$ γ's cm^{-2} sec^{-1}. The results are reported here of three high-altitude balloon flights with a gamma-ray spark chamber which observed this same region of the sky. No gammas are reported. (M.O.W.)

11468 SOLAR MODULATION OF GALACTIC COSMIC RAYS. Balasubrahmanyan, V. K.; Boldt, E.; Palmeira, R. A. R. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 72: 27-36(Jan. 1, 1967).

The modulation of galactic protons and He nuclei during the last solar cycle is analyzed according to Parker's theory. The mechanism of modulation remains essentially the same during several years of low solar activity (1961-1965). The modulation near solar maximum (1959) implies that the scale sizes of the magnetic inhomogeneities in the solar wind are reduced below the values at solar minimum. An adequate description at solar maximum would require further refinements of the theory. The proton-to-He-nucleus ratio outside the solar system is shown to be consistent with the value ≈6, in a kinetic-energy/nucleon representation, for the interval 100 to 1000 MeV/nucleon. (auth)

11469 ESCAPE CORRECTIONS FOR X-RAY SPECTRA OF CELESTIAL SOURCES. Stein, Jay A.; Lewin, Walter H. G. (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res., 72: 383-4(Jan. 1, 1967). (MIT-2098-243).

Spectra of celestial X-ray sources obtained using NaI(Tl) crystals have not been corrected so far for the escape of iodine K X rays. It is shown that such corrections may lead to considerably different conclusions as to the form of the incident X-ray spectra and consequently as to the nature of the X-ray production mechanisms. (auth)

Direct Energy Conversion

Refer also to abstracts 10545 and 11693.

11470 (LA-DC-8176) IDENTIFICATION OF THE IONIC SPECIES IN A CESIUM PLASMA DIODE. Reichelt, W. H.; Agnew, L. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 5p. (CONF-661116-2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Thermionic Conversion Specialist Conference, Houston, Tex.

The identification of the dominant ionic species in a cesium plasma diode has been experimentally determined as the atomic ion, Cs^+, rather than the often suggested molecular ion, Cs_2^+. Spec-

trographic measurements yielded electron densities, N_e, from the Stark broadening of the fundamental series lines of cesium and the atomic ion densities, N_i, from the radiative recombination spectrum leading to the 6P state. Within experimental uncertainty, for a broad range of diode operating conditions, $N_i = N_e$ and $N_i \gg N(Cs_2^+)$. (auth)

11471 (LA-DC-8178) OPTIMIZATION OF A THERMIONIC DIODE. Sutherland, C. D.; Ranken, W. A. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 9p. (CONF-661116-3). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Thermionic Conversion Specialist Conference, Houston, Tex.

Numerical solutions have been obtained for the system of first order differential equations resulting from a one-dimensional approximation to the equations representing electrical conduction and heat transport in a cylindrical thermionic diode. Power output and efficiency of a single thermionic diode are maximized with respect to emitter length, output voltage, and emitter support resistance for an emitter with a diameter of 1.2 cm, which is constrained to a maximum temperature of 2100°K. Experimentally determined current–voltage characteristics at constant cesium pressure are used to determine emission current density as a function of emitter temperature and voltage. On the basis of a simple relation for the mass of a radiation-cooled thermionic diode reactor system as a function of power output per unit area and efficiency it has been determined that optimum emitter length increases approximately 30% in going from a high-performance diode (25 W/cm^2 maximum power output at 2100°K) to a relatively low-performance diode (12 W/cm^2 maximum power output at 2100°K). (auth)

11472 (N-66-20081) HIGH-PERFORMANCE THERMIONIC CONVERTER. Quarterly Progress Report, August 13–November 13, 1965. Campbell, A. E.; Pollock, D. H. (Electro-Optical Systems, Inc., Pasadena, Calif.). Dec. 23, 1965. Contracts NAS7-100; JPL-951225. 66p. (NASA-CR-70938; EOS-6952-Q-2). CFSTI $3.00 cy, $0.65 mn.

For Jet Propulsion Lab., Pasadena, Calif.

A variable-parameter test vehicle was fabricated, loaded with cesium, and used to gather performance optimization data. Test vehicle operations demonstrated temperature measurements of 30°C for normal loads on the drive mechanism. Outgassing of rhenium and tantalum emitters resulted in minimal emitting surface grain growth after 100 hours operation at 2000°K. A molybdenum collector–copper radiator assembly was fabricated and tested; its braze-joint geometry retained its mechanical strength and integral bonding over 300 thermal shock cycles while transferring 200 and 225 watts, showed good heat rejection ability, and its copper radiating fin was not affected by thermal test cycling at 600°C. The active Ni–Zr alloy brazing of alumina to niobium remained leak tight through thermal shock cycles at the heating rate of 100°C/min. The seals also remained leak tight at 700°C cycling for 500 hours. A design analysis for the converter SN-101 has been completed. (STAR)

11473 (NASA-CR-693) THEORETICAL INVESTIGATION OF THE ABSORPTIVE PROPERTIES OF SMALL PARTICLES AND HEAVY-ATOM GASES. Krascella, N. L. (United Aircraft Corp., East Hartford, Conn.). Jan. 1967. Contract NASw-847. 73p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A theoretical investigation was conducted to determine the spectral and mean absorption characteristics of solid and gaseous elemental materials which might be utilized to control the transfer of radiant energy in the propellant region of a gaseous nuclear rocket engine. Spectral extinction, absorption, and scattering parameters were calculated, based on the Mie theory, for spherical molybdenum, niobium, tantalum, and cadmium particles having radii of 0.01, 0.05, 0.10, and 0.50 μ. Similar calculations were made for spherical tungsten particles at five temperatures between 1600 and 2400°K. The tungsten calculations were based on analytically extrapolated refractive indices for wavelengths between 0.1 and 30 μ at each temperature. The Rosseland mean absorption parameter of spherical tungsten particles having a radius of 0.05 μ was calculated for temperatures between 1000 and 5600°K. In addition, the spectral absorption parameters and normal spectral reflectivities of bulk aluminum, cadmium, carbon, cobalt, hafnium, iridium, iron, molybdenum, niobium, nickel, palladium, platinum, silicon, tantalum, thallium, titanium, tungsten, vanadium, and zirconium were calculated. The bulk absorption parameters apply to seeds in the form of thin plates and are generally higher than those for seeds in the form of spherical particles. Average reflectivities for normally incident radiation, determined by weighting the normal spectral reflectivities with respect to the black-body radiation function, were computed for aluminum, copper, gold, nickel, silver, and tungsten. The spectral absorption coefficients and Rosseland mean opacity of gaseous tungsten were re-evaluated using the UARL heavy-atom model with a modified oscillator strength distribution function. Additional average local line spacing and local line intensities for materials which might be used as gaseous seed agents were calculated. These materials included neutral iron, silicon, uranium, and vanadium as well as singly ionized niobium, tungsten, and vanadium. (auth)

11474 COMPARISON BETWEEN A DIRECT AND AN ELECTRODELESS MHD INDUCTION CHAMBER IN PULSED OPERATION. Kracik, Jiri (Technical Univ., Prague). Elektrotech. Obz., 55: 345-51(July 1966). (In Czech).

In the acceleration of plasma clusters by a magnetohydrodynamic force there are resonance states with a very high efficiency of conversion of the electric energy of the discharging circuit into kinetic energy of the cluster. Information is presented on the reverse process, that is, the conversion of the kinetic energy of the plasma flow into electrical energy in pulsed conditions. For a better understanding, the operation between two parallel electrodes is discussed. The slowing down of the plasma can proceed in such a way that a considerable part of the kinetic energy of the cluster is converted into electrical energy. Also in pulsed operation of the induction chamber it is possible to ascertain the most advantageous conditions, which means that for a given shape of the chamber and a given initial velocity of the cluster one can find a radial magnetic field that leads to a high efficiency of the conversion. Pulsed operation then is more advantageous than continuous operation, because the thermal stress of the material of the chamber is lower. (JPRS)

11475 HALL EFFECT ON MHD CURVES OF A GENERATOR WITH TWO PAIRS OF ELECTRODES. Kholshchevnikova, E. K. Zh. Prikl. Mekh. Tekh. Fiz., No. 4, 74-84(July-Aug. 1966). (In Russian).

An attempt has been made to investigate the Hall effect on the MHD curves of a generator with two pairs of electrodes in the case of their symmetrical and cross connections. The following types of electrical connections of electrodes are analyzed: conventional MHD generator with section electrodes, MHD Hall generator, combination type MHD generator, and an MHD Montardi generator. The numerical calculations were carried out with an EVM M-20 computer. Integral characteristics of MHD generators were obtained for various lengths of electrodes and insulators, external loads, and the Hall $\omega\tau$ parameter. (ATD)

11476 ENHANCED RADIATION RESISTANCE OF CONCENTRATOR SOLAR CELL PANELS. Krause, Arthur J. (Westinghouse Electric Corp., Lima, Ohio); Ferber, Robert R. Solar Energy, 10: 86-90(Apr.-June 1966).

The use of concentrator-geometry-solar cell panels provides effective geometrical shielding against charged-particle radiation in space, thereby increasing the useful life expectancy of these panels. A "V-ridge" or "trough" concentrator of a specified geometry, material, and thickness is studied. Variations in radiation damage rates and panel life are discussed with respect to cover-slip mass for circular equatorial orbits. Panel geometry, allowable cell output degradation, orbit inclination, cell type, and base resistivity variations are also discussed briefly. Three specific circular equatorial orbit cases are considered: (1) 200 n mi, corresponding to a low orbit, which is below most of the Van Allen belt radiation; (2) 2000 n mi, corresponding to an intermediate orbit which is in the highest flux region of the trapped radiation; and (3) 19,300 n mi, corresponding to a synchronous orbit essentially outside the Van Allen radiation belt but subject to solar-flare proton and cosmic fluxes. This work shows that the effective life of a solar-cell panel in an omnidirectional particle flux can be extended by as much as a factor of two by the use of concentrator geometry. (auth)

11477 STEADY ONE-DIMENSIONAL FLOW OF A CONDUCTING MEDIUM IN VARIOUS TYPES OF MHD GENERATORS. Pelz, Pavel (Czechoslovak Academy of Sciences, Prague). Acta Tech. CSAV, 11: 527-43(1966).

Basic equations for a steady-state one-dimensional flow of a conducting medium through the channel of an MHD generator in a homogeneous magnetic field are formulated. Generator cooling by transfer of a constant quantity of heat from a unit area of the wall surface and by friction against the walls of a constant cross-section channel is considered. The Faraday generator, with the load obliquely connected, and the Hall generator, with oblique shorting straps, are considered. The dependences of temperature and the longitudinal coordinate upon velocity are obtained by solving a basic system of nonlinear differential equations. Other parameters of the state of the medium, the specific generator power output, and components of the electric field intensity and current density, as functions of the distance from the input of the channel are then derived from these. Finally, terminal voltages of various types of generators are derived. (Int. Aerospace Abstr.)

11478 THEORY OF THERMIONIC CONVERTER EXTINGUISHED-MODE OPERATION WITH APPLICATIONS TO CONVERTER DIAGNOSTICS. Wilkins, Daniel R.; Gyftopoulos, Elias P. (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 38: 12-18(Jan. 1967).

An analysis of thermionic converters operating in the extinguished mode is presented. Expressions for the forward and reverse saturation output current densities and for the open circuit voltage are derived for the first time from a single set of transport equations and boundary conditions. Agreement between theoretical and experimental results is established. It is shown that the output current density cannot exceed a certain upper limit which depends only upon the emitter temperature and the interelectrode spacing, and is independent of the emitter work function and the cesium pressure. It is shown that, under certain operating conditions, measurements of the forward and reverse saturation output-current densities and of the open circuit voltage can be used to infer values of the emitter temperature, emitter work function, collector work function, and electron and ion mobilities. (auth)

11479 THE EFFECT OF COLD ELECTRODE BOUNDARY LAYERS ON THE ELECTRICAL CHARACTERISTICS OF DC MHD GENERATORS. Celinski, Zdzislaw (Inst. of Nuclear Research, Polish Academy of Sciences, Swierk). Nukleonika, 11: 615-28(1966).

The conditions of forming space charge and eddy currents in the ionized gas flow in MHD channel were determined. The results of the study show the strong effect of the cold electrode boundary layer on the electrical performance of the MHD generator and permit its quantitative determination. Electrode cooling greatly contributes to the deterioration of the electrical performance of the generator. (auth)

Fluid Physics

11480 INTERACTION OF THE LUMINESCENT FRONT IN ELECTRODYNAMIC SHOCK TUBES WITH TRANSVERSE MAGNETIC FIELDS. Goryaga, G. I.; Kokorev, A. I.; Persiantseva, N. M. Vestn. Moskov. Univ., Ser. III: Fiz. Astron., No. 4, 3-8 (July-Aug. 1966). (In Russian).

The nature of the luminescent front in electrodynamic shock tube was investigated. The experiments made on the interaction of the luminescent front with transverse magnetic fields indicated that the luminescent front matches the followed boundary of plasma bunches emitted by discharge chambers. The collision wave front becomes visible only after its interaction with some obstruction. (tr-auth)

11481 ELECTROVISCOUS FLUIDS. II. ELECTRICAL PROPERTIES. Klass, Donald L. (Illinois Inst. of Tech., Chicago); Martinek, Thomas W. J. Appl. Phys., 38: 75-80(Jan. 1967).

The induced interfacial polarization mechanism invoked to explain electroviscosity requires a direct relationship between the rheological and electrical properties of an electroviscous system. Static and dynamic measurements of the electric and dielectric properties of electroviscous silica dispersions were made to study these relationships. An electrokinetic potential and conductivity and a small dc power output that depend upon shear rate were observed. Electroviscous fluids under shear exhibit the characteristics of small electric cells. Shear-induced desorption of weakly held charge carriers out of the double layer is suggested to explain these effects. On application of an external electric field, electroviscosity appears at the onset of current flow. Dielectric measurements under zero-shear conditions show that the medium in contact with the disperse phase is essentially a low-dielectric-constant vehicle while the particles are composites having higher dielectric constants, thereby facilitating interfacial polarization. Anomalous dispersion occurs under zero-shear conditions at low frequencies as expected on the basis of the proposed interfacial polarization mechanism. Simultaneous dielectric-constant, loss, and electroviscosity measurements under shear conditions correlate with the effects of changing shear rate, field strength, temperature, and frequency. Increasing temperatures promote polarization while shear stresses transverse to the direction of the applied field perturb the field-induced polarization. When an electroviscous dispersion is subjected to both mechanical shearing and an external electric field, a dynamic equilibrium is established between the rheological and electrical properties of the system. (auth)

11482 ELECTROVISCOUS FLUIDS. I. RHEOLOGICAL PROPERTIES. Klass, Donald L. (Illinois Inst. of Tech., Chicago); Martinek, Thomas W. J. Appl. Phys., 38: 67-74(Jan. 1967).

Electroviscosity is defined as an essentially instantaneous reversible change in apparent viscosity when a fluid is subjected to an externally applied electric field. The electroviscous properties of silica and calcium titanate dispersions are typical of most electroviscous systems and were found to be a function of many parameters such as composition, shear rate, field strength, frequency, and temperature. When only one parameter is varied, electroviscous effects increase with increasing volume fraction of disperse phase, field strength, and temperature, but decrease with increasing shear rate and frequency. Electroviscosities are proportional to the square of the field strength and inversely proportional to the first power of the shear rate. Induced interfacial polarization on and near the particle surface and the resulting interactions between the polarized double layers, and the polarized double layers and particles are used to explain the electroviscous phenomenon. (auth)

11483 FLAME IONIZATION AND MAGNETOHYDRODYNAMICS. Debiesse, Jean; Klein, Siegfried (Centre d'Etudes Nucleaires, Saclay, France). Nature, 212: 1405-8(Dec. 24, 1966).

Research in magnetohydrodynamics and attempts at its application to power generation have been much stimulated, in the past two years, by a series of experiments carried out at Centre d'Etudes Nucléaires at Saclay. The authors of this work have prepared a summary of their principal findings, which center on the important part played by negative ions in flames and by negative droplets in mercury vapor. It turns out that flames can be considered as gaseous semiconductors. The use of isotopic tracer techniques in the study of flames and plasmas has also provided a powerful means of confirming the results of electrical measurements hitherto dependent on the use of probes. This method is rich in possibilities. (auth)

11484 MAGNETOHYDRODYNAMICS. Jeffrey, Alan. University Mathematical Texts. New York, John Wiley and Sons, Inc., 1966. 260p. $3.50.

An introduction to magnetohydrodynamics based on sound but straightforward mathematical grounds is presented. The work differs from the usual discussions of waves in that it describes and uses the theory and characteristics which is necessary for a proper discussion of the important effects of nonlinearity. It is shown how MHD simple waves can be analyzed exactly and can tend to discontinuous solutions of the MHD equations that are called shocks. A brief discussion is also given of the spatial discontinuities that can occur in MHD and the analytical results are given simple geometrical interpretations. (W.D.M.)

Geophysics

Refer also to abstracts 10696 and 11332.

11485 (AD-640722) REGULAR VARIATIONS OF THE CONTENT OF ELECTRONS IN THE LOWER PART OF LAYER F_2 OF THE IONOSPHERE AT THE MIDDLE LATITUDES. Shchepkin, L. A. Translated from pp 66-74 of Issledovannie po Geomagnetizmu i Astronommi, Akademiya Nauk SSSR, 1963. 20p. (FTD-MT-65-489). CFSTI $3.00 cy, $0.65 mn.

The formation and variations of the electron content of the ionospheric F2 layer are discussed. Information is included on time variations, seasonal changes of conditions of ion formation in the F region, and anomalies of the seasonal variation of electron content at midday. (J.H.M.)

11486 (N-66-19194) OBSERVATIONS WITH UNIVERSITY OF IOWA EQUIPMENT ON MARINER IV, NOVEMBER 1964-FEBRUARY 1965. Preliminary Report. Van Allen, J. A.; Krimigis, S. M.; Frank, L. A. (State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy). Feb. 22, 1965. Contracts NAS7-100; JPL-950613. 23p. (NASA-CR-70380). CFSTI $3.00 cy, $0.65 mn.

For Jet Propulsion Lab., Pasadena, Calif.

Observations of electron and proton levels recorded by detectors on the Mariner IV space probe during passage through the earth's magnetosphere and interplanetary space are presented. The detectors consisted of Geiger-Mueller tubes and a surface barrier solid state proton detector with two discrimination levels. Graphs are plotted for the electron and proton levels in the earth's magnetosphere. The outer boundary of the transition region was found to be at 23 earth radii and there was a single detached spike of low energy electrons at 25.7 earth radii. There was a marked reduction of low energy particles in interplanetary space compared to Mariner II probe data, which may be associated with reduced solar activity. A search for the earth's magnetospheric wake at 3020 earth radii by increased detector counts was negative. Two solar cosmic ray events were recorded. The particles of the first event were identified as protons and not electrons. The second event was complex with decreasing flux of energetic particles. (STAR)

11487 (N-66-19717) PLASMA AND SPACE PHYSICS. Scarf, Frederick L. (Stanford Univ., Calif. Dept. of Aeronautics and Astronautics). [1965]. Contract NSR-05-020-88. 130p. (NASA-CR-71028). CFSTI $3.00 cy, $0.65 mn.

Some properties of the fully ionized gases which extend over the vast region of space from the base of the solar atmosphere to the top of the earth's ionosphere are discussed. Brief descriptions are given of the main physical features of the solar corona, the interplanetary medium, the ionosphere and magnetosphere, and collisions and plasma equilibrium, as a basis for detailed examination of the properties of the corona, solar wind, magnetosphere, and transition region. The areas of continuum plasma dynamics and problems in solar wind theory are also considered. (STAR)

11488 (N-66-25013) FLOW OF PLASMA IN A SLIGHTLY ROTATIONAL MAGNETIC FIELD. Hiroshige, Y. (Jet Propulsion Lab., Pasadena, Calif.). Aug. 10, 1962. Contract NAS7-100. 17p. (NASA-CR-74848; JPL-TM-33-96). CFSTI $3.00 cy, $0.65 mn.

A solution for a flow of plasma away from the sun in a slightly rotational magnetic field has been determined, assuming that the plasma is incompressible and inviscid and has infinite electrical conductivity. The magnetic field vector is shown to be a constant multiple of the velocity vector, and the problem is reduced to finding the solutions to the vorticity equation and inhomogeneous elliptic-type partial differential equation. An analytic solution is obtained for the case of constant rotation, and streamlines are plotted showing the influence of a rotational field. (auth)

11489 (NP-16456) RESULTS OF SIXTEEN DIFFERENTIAL ABSORPTION AND FARADAY ROTATION MEASUREMENTS WITH NIKE-APACHE ROCKETS. Gooch, J.; Krone, H.; Skaperdas, D. (Illinois Univ., Urbana. Coordinated Science Lab.). Oct. 1966. 85p. (R-324). CFSTI $3.00 cy, $0.65 mn.

A compilation of D-layer differential absorption and Faraday rotation data versus altitude obtained from a series of 16 rocket probes at various geomagnetic latitudes is presented. (auth)

11490 (NP-16459) THE VALIDITY OF THE O_2^- MODEL FOR D-REGION RECOMBINATION. Kaufman, Alfred (Lockheed Missiles and Space Co., Palo Alto, Calif. Research Labs.). Nov. 1966. Contract NOnr3368(00). 17p.

The adequacy of the O_2^- model for predicting the response of the atmosphere to ionizing radiation is examined in the light of observations of nuclear weapon effects and polar cap absorption events. The model appears to give reasonable agreement with observations in the first category, but is inconsistent with data from the second. The inadequacy of the model seems to be related to the amount of atomic oxygen and ozone naturally present and produced during recombination. Latest measurements of rate constants for several important negative ion reactions are also given. (auth)

11491 (UCID-15064) ON THE AVAILABILITY OF PHASE SPACE DURING THE BUILDUP OF THE E-LAYER. Christofilos, N. C. (California Univ., Livermore. Lawrence Radiation Lab.). Dec. 20, 1966. Contract W-7405-eng-48. 9p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Calculations for determining the buildup of the ionospheric E region are described. The numerical description begins with an equation for the total number of electrons in the E region. Under the conditions discussed there does not appear to be any limit in phase space to inhibit E-region buildup to the field reversal level. (J.H.M.)

11492 (JPRS-38793) STUDIES OF THE INTENSITY AND SPECTRAL COMPOSITION OF LUNAR GAMMA RADIATION BY THE AUTOMATIC STATION "LUNA-10." Vinogradov, A. P.; Surkov, Yu. A.; Chernov, G. M. Translated from Dokl. Akad. Nauk SSSR, 170: 561-4(1966). 6p. (TT-66-35217). CFSTI $3.00 cy, $0.65 mn.

For the investigation of the intensity and spectral composition of gamma radiation of lunar rocks, a 32-channel scintillation gamma spectrometer was mounted aboard Luna-10, which was put into a selenocentric orbit on April 3, 1966. An attempt was made to estimate the relative content of K, Th, and U in rocks which make up the lunar surface. One gamma spectrum for lunar rocks, after background subtraction, is shown. The identified gamma energies are tabulated. (J.H.M.)

11493 (JPRS-38795) STUDY OF SOFT CORPUSCULAR RADIATION BY THE LUNAR SATELLITE "LUNA-10." Grigorov, N. L.; Maduev, V. L.; Mandelshtam, S. L.; Pisarenko, N. F.; Savenko, I. A.; Tindo, I. P. Translated from Dokl. Akad. Nauk SSSR, 170: 567-9(1966). 5p. (TT-66-35219). CFSTI $3.00 cy, $0.65 mn.

Instruments carried by the satellite Lunar-10 to record soft corpuscular radiation are described. The arrangement and readings of the counters are discussed and presented schematically. The data indicate the existence of the tail of the earth's magnetosphere at a distance to 60 earth radii in the antisolar direction. (J.H.M.)

11494 (JPRS-38796) INDICATIONS OF LUNAR INTERSECTION OF THE TAIL OF THE EARTH'S MAGNETOSPHERE ACCORDING TO DATA FROM CHARGED PARTICLE TRAPS ON THE FIRST ARTIFICIAL LUNAR SATELLITE. Gringauz, K. I.; Bezrukikh, V. V.; Khokhlov, M. Z.; Musatov, L. S.; Remizov, A. P. Translated from Dokl. Akad. Nauk SSSR, 170: 570-3 (1966). 6p. (TT-66-35220). CFSTI $3.00 cy, $0.65 mn.

Luna-10 carried four charged-particle traps. Measurements made using two of the traps are presented. Types of components included in the traps are discussed. Measurements indicate that at the time of the experiments the moon (together with its satellite) emerged from the tail of the earth's magnetosphere in which there are fluxes of electrons with $E_e > 70$ eV, and then with the approach of the May full moon again entered into the tail of the earth's magnetosphere. (J.H.M.)

11495 ANOMALOUS DIFFUSION OF CHARGED PARTICLES IN EARTHS MAGNETOSPHERE. Ershkovich, A. I.; Shalimov, V. P. Kosm. Issled., 4: 788-91(Sept.-Oct. 1966). (In Russian).

Charged particles are transported most effectively across the drifting magnetic belt of the earth under the influence of the azimuthally nonsymmetric magnetic perturbations due to sudden pulses. The maximum of the belt is formed in areas in which the specific transport times and losses are identical. This problem was examined for protons with energies exceeding 0.1 MeV, taking into account that as the proton energy increases, their intensity maximum shifts toward the earth. It was assumed that the particle source was located at the boundary of the belt. Data from the Explorer-12 were used for the calculation. The results indicate that with increasing value of k in the fundamental equation of the transport theory, the divergence between theoretical predictions and experimental data becomes more marked. However, the diffusion at $k \rightarrow 0$ (diffusion without regular drift) cannot be attributed to intensity variations; it may be due to an overestimation of the role of diffusion processes in the formation of the external proton belt. (TTT)

11496 AN INVESTIGATION OF MICROPULSATIONS AT MIDDLE LATITUDES. Stuart, W. F.; Usher, M. J. (Imperial Coll. of Science and Tech., London). Geophys. J., 12: 71-86 (Nov. 1966).

Rubidium magnetometers were set up at the three United Kingdom observatories and simultaneous recordings of micropulsations occurring in the total field direction were obtained for the second half of 1964. An analysis of these records is described which brings out the general features of micropulsations and which indicates some differences between occurrences at the three stations. A latitude dependence of period is displayed, and the occurrence time of P_c is shown to be distinctly different at Lerwick and Hartland. It is indicated that harmonic components occur in the wave trains, but they do not appear in the general analysis reported here. (auth)

11497 ENERGY OF CONFINEMENT OF A SHIELDED MAGNETIC DIPOLE FIELD. Carovillano, R. L.; Maguire, J. J. (Boston Coll.). Geophys. J., 12: 23-8(Nov. 1966).

A general theorem is established which determines the interaction energy required to confine a shielded magnetic dipole field by a diamagnetic surface of arbitrary shape. Since Chapman has demonstrated that the joint energy vanishes for this case, one needs only to evaluate the self-energy of the disturbance field. This energy is obtained as the simple point function $-M.h_{sc}(0)/2$, where M is the dipole moment and $h_{sc}(0)$ is the perturbation field at the position of M due to currents on the confining diamagnetic surface. For a given $h_{sc}(0)$, the interaction energy is independent of the form of the plasma boundary; this result was suggested by Chapman. Several physical examples revealing certain subtleties of the derived theorem are discussed. (auth)

11498 SPECTRAL COMPOSITION OF DIRECT SOLAR RADIATION. Lopukhin, E. A. (Sredneaziatskii Nauchno-Issledovatelskii Gidrometeorologicheskii Institut, Tashkent). Appl. Solar Energy (USSR)(Engl. Transl.), 1: 36-40(Jan.-Feb. 1965).

Translated from Geliotekh., Akad. Nauk Uz. SSR, 1: 44-8(Jan.-Feb. 1965).

Data are tabulated on the spectral composition of direct solar radiation in lowland areas for different humidities and aerosols, as well as in mountain areas. For the same solar altitude there is little change in the percentage of IR rays in the total integral radiation flux on days with different atmospheric transmissions. There is a marked displacement of the aerosol absorption bands in relation to changes in the spectral composition of the direct solar radiation. The percentage of IR rays varies strongly with

the height of the sun, especially on days with different atmospheric transmission. (Int. Aero. Abstr.)

11499 DETERMINATION OF THE IONOSPHERIC ELECTRON CONTENT AND ITS HORIZONTAL GRADIENT, BY MEANS OF SATELLITE SIGNALS. Houminer, Zwi (National Committee for Space Research, Haifa, Israel). Israel J. Technol., 4: 63-9 (1966).

Various methods for calculating the total electron content of a vertical column in the ionosphere are discussed. The methods utilize the effect of Faraday fadings of satellite signals and use amplitude records of either one frequency (20 Mc) or closely spaced frequencies (40 and 41 Mc). The total content of the ionosphere above Haifa was deduced from observation of the S-66 satellite, during the period Nov., 1964, to June, 1965. The results revealed the expected strong diurnal variations, and confirmed earlier measurements made elsewhere showing the fast rise in the morning and the shift of the maximum into the hours of the afternoon. A seasonal variation, which shows higher values of electron content at spring and summer with respect to winter, was also observed. A method for calculating the ionospheric horizontal gradient is proposed. The gradient will give the latitudinal dependence of the total content. The results indicate higher electron concentration, during daytime, at southern latitudes in comparison to northern latitudes. (BBB)

11500 IONOSPHERIC STUDIES USING THE TRACKING BEACON ON THE EARLY BIRD SYNCHRONOUS SATELLITE. Koster, J. R. (Univ. of Ghana, Legon). Ann. Geophys., 22: 435-9(July-Sept. 1966).

To monitor total electron content of the ionosphere over the equator, continuous observations were made of the 136-Mc signal irradiated by the Early Bird satellite for 81 days. During times of scintillation 3 stations, with a maximum spacing of 21 km, were used. Results include information on the diurnal variation of total electron content, and new information on equatorial scintillation and the irregularities giving rise to it. Daytime scintillation was less common (it occurred 42 times during the 81-day period, vs 95 times for nocturnal scintillations), and was also usually of considerably shorter duration and of smaller amplitude. The average duration for daytime scintillation was less than 30 min, while that at night was 95 min. Polarization effects played a negligible role in the amplitude scintillation of a satellite signal. The distribution of amplitude in a signal during times of scintillation was nearly Rayleigh. The diffraction pattern on the ground during equatorial scintillation had virtually infinite elongation along the magnetic N-S direction. The nighttime velocity of drift was towards the east, with a mean amplitude of 78 m/sec. It is concluded that a synchronous satellite offers a unique and relatively simple means for continuously monitoring the total electron content of the equatorial ionosphere. (BBB)

11501 PRACTICAL PROBLEMS ENCOUNTERED IN ROCKET STUDIES OF GEOPHYSICAL DISTURBANCES. Heikkila, W. J. Can. Aeron. Space J., 12: 433-8(Dec. 1966).

Difficulties expected to be experienced in recording ionospheric activity relating to predictable and random solar events are reviewed. Predictable events include disturbances of short duration (twilight conditions and eclipse phenomena) and medium duration (diurnal or seasonal variations). Random disturbances include auroral phenomena and polar cap absorption events. Rocket investigations of such short-lived, unpredictable geophysical disturbances involve many practical difficulties. It is necessary to have the rockets, payloads, and ground stations ready and checked out, and then to wait for suitable launching conditions. The countdown procedure may have to be held for hours at a few minutes short of launching while waiting for the disturbance. The geophysical conditions must be diagnosed quickly and reliably with the aid of information obtained either locally or from distance locations. It may be necessary to have many launchings before meaningful results are obtained. It may be desirable to include several different but related experiments in each payload. These problems are considered in detail. (BBB)

11502 SIXTEEN-CHANNEL SILICON INTEGRATED-CIRCUIT ENCODER FOR THE ISIS "A" SATELLITE PARTICLE-COUNTING EXPERIMENT. Shepertycki, T. H. (National Research Council, Ottawa). Can. Aeron. Space J., 12: 403-8(Dec. 1966).

A description is given of an integrated-circuit data encoder built for the ISIS A satellite energetic-particle-counting experiment devised to measure the angular distributions and energy spectra of electrons ranging from 20 keV to greater than 2.8 MeV and of protons ranging from 150 keV to greater than 45 MeV. The detection of these particles is accomplished by 11 particle detectors located on the skin of the satellite. The pulses from these detectors due to electrons and protons are amplified and passed through amplitude discriminators prior to being sent over to the encoder package for further data processing. The pulses are counted over a $\frac{1}{4}$-sec period by 14 counters; each counter is capable of either accumulating a total of 2^{15} pulses or being divided to provide one 2^7 and one 2^8 counter. To provide directional information, the analogue voltages from 4 magnetometers and 2 reference voltages are selected by an 8-position subcommutator and converted into digital form by a ramp-type analogue-to-digital converter. The encoder organizes these and other data, which are read out sequentially at an 11.52 KHz bit rate, into frames with each frame comprising sixteen 16-bit words. The encoder, which is functional from −50°C to +70°C, contains 433 silicon integrated circuits, 248 microminiature diodes, 44 transistors, and 75 other discrete components in a 4-lb package, $7\frac{1}{2}$ in. × 4 in. × $3\frac{1}{2}$ in. Power consumption is about 1 W. (BBB)

11503 IONOSPHERIC HORIZONTAL DRIFTS WITHIN THE EQUATORIAL ELECTROJET REGION IN INDIA. Deshpande, M. R.; Rastogi, R. G. (Physical Research Lab., Ahmedabad, India). Ann. Geophys., 22: 418-21(July-Sept. 1966).

To study the movements in the ionospheric layers by measurements made close to the magnetic equator, an ionospheric drift station was established at Thumba (latitude 8°32′N, longitude 76° 52′, magnetic dip 0.6°S) in South India. Regular measurements of the horizontal drifts in E and F region of the ionosphere have been made since January 1964. The average drift direction and speeds in the E as well as the F regions during the period January to December, 1964 are described. The experimental set-up consisted of a radio frequency pulse transmitter, receiving and recording systems, and transmitting and receiving aerial system. Results show that the direction of drifts in both E and F regions during the daytime hours was predominantly towards the west. The speed of drift was found to be higher at Thumba than at any other station of the world, the average values being 132 m/sec for E and 161 m/sec for F region. The drift speed showed a strong daily variation, having a maximum at about 0.9 to 11 hr and minimum in the afternoon hours. There was no significant seasonal variation in speed or direction. (BBB)

11504 SOME STUDIES OF NIGHTTIME F-LAYER IRREGULARITIES AT THE EQUATOR USING VERY-HIGH-FREQUENCY SIGNALS RADIATED FROM EARTH SATELLITES. Kent, G. S.; Koster, J. R. (Univ. of the West Indies, Kingston, Jamaica). Ann. Geophys., 22: 405-17(July-Sept. 1966).

The equatorial F-layer usually contains irregularities in electron density at night and these irregularities greatly change the characteristics of a wave reflected from the layer or transmitted through it. A description is given of studies made in Ghana during 1962 and 1963 on the nature of the nighttime irregularities responsible for scintillation of radio signals received from radio stars and earth satellites. The method involved study of the diffraction patterns formed on the ground by such waves after they had passed through the ionosphere. Signals were received on 3 spaced aerials. Numerical methods of correlation analysis, more powerful than the usual graphical methods, were developed to analyze fading of these signals. It was found that the irregularities are highly elongated with axial ratios of the order of 20 : 1 and are aligned along the earth's magnetic field lines. Estimates of their height show that the irregularities occur in a layer about 100 km thick at ~300 km above the earth. (BBB)

11505 MODEL FOR THE INTERPRETATION OF IONOSPHERIC DRIFTS MEASUREMENTS. Kent, G. S. (Univ. of the West Indies, Kingston, Jamaica). Ann. Geophys., 22: 427-34(July-Sept. 1966).

The problem considered is concerned with the interpretation of measurements, made on the ground, of the diffraction pattern formed when the ionosphere reflects or scatters a high-frequency radio wave radiated upwards. A model is described for the interpretation of ionospheric drift measurements, made by the spaced receiver method, when the wave scattered from the ionosphere has a frequency considerably above that of the plasma frequency of the scattering region. This model is analyzed in terms of the Fourier transform relation connecting the power spectrum of the scattered wave and the autocorrelation function of the diffraction pattern on the ground. Under these conditions the statistical parameters of the diffraction pattern on the ground are interpreted in terms of similar parameters of the scattering irregularities and, in particular, it is shown how their random velocity of motion may be determined. The model developed is applicable only to elongated irregularities and this, and other limitations to it, are discussed and suggestions for their elimination outlined. This model was primarily developed to interpret measurements made on equatorial sporadic E, in which both forms of irregularity are likely to occur. (BBB)

11506 IONOSPHERIC TEMPERATURE AND COMPOSITION MEASUREMENTS AT THE MAGNETIC EQUATOR. Farley, D. T. (Jicamarca Radar Observatory, Lima). Ann. Geophys., 22: 448-53(July-Sept. 1966).

Measurements of the temperature and ion composition of the equatorial ionosphere were made, using the incoherent scatter technique, during the period August 17–19, 1965, at Jicamarca. The altitude range covered was 200 to 1000 km. The concentration of H^+ above 500 km was ~1 to $2 \times 10^4/cm^3$ and was nearly independent of altitude and time of day. In no case was He observed to be the predominant ion. The altitude at which the relative concentration of oxygen ions reached 50% was about 600 to 700 km at night, and rose to greater than 900 km during the day. During most of the day the ion temperature was of the order of 900 to 1100°K in the altitude range 200 to 500 km. It then rose sharply to at least 2000°K at 1000 km. The electron temperature at midday had a maximum of about 2000 to 2500°K near 250 km. With increasing altitude the electron temperature at first fell, reaching equilibrium with the ion temperature at about 350 km, and then rose again with the ion temperature. At night the ionosphere above 200 km was very nearly isothermal, with both T_e and T_i dropping to values of 600 to 800°K. (BBB)

11507 COSMIC-RAY CUTOFFS DURING GEOMAGNETIC STORMS. Solomon, A. I. (Fairchild Hiller Corp., Farmingdale, N. Y.). J. Geomagnet. Geoelec., 18: 343-7(1966).

During solar disturbances it is sometimes found that a disturbance of the magnetic field in the vicinity of the earth accompanies the enhanced solar particulate radiation. This distortion of the earth's magnetic shielding affects the particle precipitation on the earth. A general expression is given for the particle cut-off during magnetic storms for all directions of entry. (J.H.M.)

11508 EXPERIMENTAL STUDY OF THE EQUATORIAL IONOSPHERE ANOMALY IN AFRICA IN PERIODS OF MINIMUM SOLAR ACTIVITY. Vila, Paul (CNET, Issy-les-Moulineaux, France). Ann. Geophys., 22: 396-404(July-Sept. 1966). (In French).

Stations in Algeria and Nigeria (longitude 0° to 5°E and latitude 23°N to 4°S) were used to examine the F region ionization equatorial anomaly with the help of airborne sounding during March–April and June–July 1965, periods of minimum sunspot activity. At these longitudes, the 2 periods corresponded to symmetrical opposite positions of the sun. On a 3-dimensional representation of the iso-f_0F2 lines with latitude local time and altitude coordinates, various characteristic zones appeared: first, a central depleted equatorial plateau at high altitudes; this plateau was crossed, roughly parallel to the magnetic equator, by a narrow trough of minimum ionization which moved northwards during the day; second, on the North and South edges of this plateau, 2 maximum ionization crests which developed and widened unevenly during the morning across subtropical latitude zones. The warmer crest, under the ecliptic, grew very slowly, to reach its diurnal maximum as late as 17.00 L.T. The cold crest, less directly exposed to the solar ionizing fluxes, concentrated rapidly before 12.00 L.T., forming a narrower and much denser maximum of tropical ionization. This distribution could not be explained by present theories. Photoelectron production and atmospheric heating are suggested as mechanisms for the differentiation of the magnetic tubes of force of the equatorial F-region ionization. (BBB)

11509 EFFECT OF RADIOACTIVE FALLOUT UPON THE ELECTRICAL CONDUCTIVITY OF THE LOWER ATMOSPHERE. Huzita, Akira (Radiation Centre of Osaka Prefecture, Sakai). J. Geomagnet. Geoelec., 18: 363-72(1966).

The effect of radioactive fallout upon the electrical conductivity of the lower atmosphere was studied. The records of atmospheric conductivity which were made at the Geophysical Institute of Kyoto University in the period from 1961 to 1963 were compared with the records of the observation of fallout made in the same period at the Radiation Centre of Osaka Prefecture. The radioactive fallout, which originated from the large scale nuclear test explosion of 50 megaton class carried out by the U.S.S.R. at Novaya Zyemlya on October 30, 1961, caused a temporary increase in atmospheric conductivity up to the value twice as high as the normal value. The increase in conductivity was caused mainly by radiations from the dry fallout accumulated on the ground surface, which was estimated to have exceeded 250 $m\mu Ci/m^2$ at that time. On the other hand, radiations from the airborne nuclear debris, the concentration of which reached as high as 120 $\mu\mu Ci/m^3$ at that time, were considered to have contributed little to the increase in conductivity. (auth)

11510 LAYER STRUCTURE IN THE ELECTRON TEMPERATURE PROFILE IN THE IONOSPHERE. Hirao, Kunio (Tokyo Univ.). J. Geomagnet. Geoelec., 18: 333-41(1966).

Electron temperature profiles in the ionosphere were measured with the K-10S-1 sounding rocket in both up and down legs. The electron temperature probe was installed on the top of the payload perpendicular to the spin axis, and the measurement of the electron temperature was so free from interference with the attitude that the measured electron temperature has very small dispersion and is quite reliable. The probe was flown up to maximum altitude of about 720 km from the Kagoshima Space Center. The measured electron temperature profile covers both bottom and top sides of the ionosphere. The result shows apparently a quite different profile between the upleg and the downleg ones, especially at the height of about 200 km. However, a remarkable similarity between these two profiles can be found when the altitude scales are shifted about 60 km from each other. There seems to be a layer structure which inclines upward toward the southeast direction; and the temperature decreases about 200°K from northwest to southwest. It seems that the layer structure of the electron temperature is caused by the atmospheric constituent of the ionosphere, and the temperature difference between both legs is related to the latitudinal electron temperature distribution. (auth)

11511 EFFECTIVE RECOMBINATION COEFFICIENT IN THE D REGION. Parthasarathy, R.; Rai, D. B. (Univ. of Alaska, College). Radio Sci., 1: 1397-1400(Dec. 1966).

Multiple-frequency (5-50 Mc) radio wave absorption data taken during a polar-cap event is used to derive an electron density profile for the lower ionosphere. By comparing this profile with an ionization rate profile calculated using measured particle flux, the effective recombination coefficient is obtained for the 50–90 km height region. (auth)

11512 EFFECT OF METEORIC DUST ON THE EFFECTIVE RECOMBINATION COEFFICIENT IN THE LOWER IONOSPHERE. Parthasarathy, R.; Rai, D. B. (Univ. of Alaska, College). Radio Sci., 1: 1401-8(Dec. 1966).

The effect of meteoric dust particles on the steady-state distribution of electrons and ions in the lower ionosphere (50–90 km) was investigated. A formal expression for the effective recombination coefficient was also derived, containing the terms for the rates of capture of electrons and positive and negative ions by the dust. These capture rates are derived by an extension of Natanson's theory of aerosol charging by the capture of ions. The altitude dependence of these coefficients is mainly determined by the altitude distribution of the dust concentration. It is found that only particles with radii larger than about a tenth of a micron play a significant role. The numerical values of the effective recombination coefficient for several altitudes in the D region were compared with the values empirically determined from multiple-frequency radio-wave absorption data in the auroral zone, and found to be in satisfactory agreement. It is also shown that the role of dust concentration in the D region is of major significance when the ionization density is weak to moderate. For a strongly ionized D region, the role is significant only if the dust concentration is higher than is currently believed probable. (auth)

11513 PRELIMINARY RESULTS OF DIFFRACTION PATTERN MEASUREMENTS AT NAIROBI. Kelleher, R. F. (Univ. College, Nairobi, Kenya). Ann. Geophys., 22: 422-6(July-Sept. 1966). (In French).

Ionospheric anomalies were investigated on the basis of measurements made by the spaced-receiver method on the ground diffraction pattern of vertically reflected radio waves. A ground-based transmitter on a frequency of 2.15 Mcps was set up in Nairobi in March 1965. A description is given of the equipment, the method of reducing the data, and the results obtained, and the significance of some information on axial ratios obtained from this and other stations is considered. A table shows the median values obtained for the following parameters: r, axial ratio of the characteristic ellipse; V, drift velocity of the ground pattern; V_c, random velocity; and d, length of the semi-minor axis of the spatial ellipse The value of r for the E region was significantly higher than that found at Singapore where the dip angle is 18° (as against 27° for Nairobi). The axial ratios increased fairly rapidly with the virtual height of reflection in the range 95 to 150 km. There was a tendency for the diffraction patterns to be elongated along a north-west/south-east direction. In the E region the drift was towards the east from midnight up to about 0600 LMT; it reversed direction during the daylight hours and was again towards the east in the evening. The individual north-south velocities were generally smaller than the east-west components (the median values are 26 m/sec and 43 m/sec respectively). The trend seemed to be northwards around sunrise and southwards at other times. For the F region the one occasion when spread F echoes were recorded, there was a very high velocity (236 m/sec) due south. (BBB)

11514 SOME HIGH-FREQUENCY OBSERVATIONS OF EQUATORIAL SPORADIC-E IRREGULARITIES. Kent, G. S. (Univ. of the West Indies, Kingston, Jamaica). Ann. Astrophys., 29: 368-79(Sept.-Oct. 1966).

The equatorial sporadic E layer of the ionosphere appears to be a thin semitransparent layer which shows on an ionogram as a partially reflected echo of constant height, extending to frequencies

above 10 Mc, occurring principally between 0800 and 1800 local time. Echoes reflected from it are found to fade faster than those reflected from either the E or the F region, and the shape of the diffraction pattern formed on the ground shows that the irregularities comprising the layer are elongated along the earth's magnetic field. Results are presented which were obtained from measurements made on sporadic E irregularities over Ibadan, Nigeria. The properties of these irregularities which were studied are the scattering spectrum and the diffraction pattern formed by reflection on the ground. Several frequencies have been employed between 3 and 7 Mc and the irregularities were found to be elongated along a magnetic north–south axis, and to scatter radiation almost isotropically in an east–west plane. Measurements made on their movements showed that they normally drift to the west with a mean velocity which may vary between 0 and 125 m/sec. Superimposed on this steady drift was a random component of velocity, usually about 150 m/sec. The interpretation of these results in terms of a model is difficult and it seems quite likely that there may be more than one class of irregularity present. (BBB)

11515 IONOSPHERIC DIURNAL VARIATIONS IN THE F-LAYER AT IBADAN OVER A SUNSPOT CYCLE. Olatunji, E. O. (Ibadan Univ., Nigeria). Ann. Astrophys., 29: 393-5(Sept.-Oct. 1966).

Local time variations of ionospheric parameters close to the magnetic equator are of interest from 2 complementary points of view: from the aspect of variations with time and height at a station, and how these variations affect those at other low latitudes. Hourly values of f_0F2 and h_mF2 obtained at Ibadan (3.9°E, 7.45°N, dip 5.8°S) over a complete solar cycle are analyzed to reveal the pattern of diurnal variation at different seasons and for different epochs of the solar cycle. Data for magnetically quiet days (i.e., days with Ap < 30) only have been used. Such quiet-day values for a given month are arranged to give monthly medians for each hour of day. These median values were then averaged over a period of 3 months to give an average diurnal variation. Results showed that at sunspot maximum, the diurnal peak of f_0F2 variation occurred before noon while sunspot minimum exhibited a post-noon peak. The variation of h_mF2 retained the same form at all solar epochs. The postsunset increase of h_mF2 was much more pronounced at sunspot maximum than at sunspot minimum. This does not appear to be related to variations of the structure of the equatorial anomaly, as this anomaly persists much later into the night. Greater densities of neutral particles at sunspot maximum may account for the greater variation of h_mF2 soon after sunset. The very small range of variation of h_mF2 near sunrise throughout the solar cycle is considered as due to the dominance of solar radiation in determining h_mF2 near sunrise. That f_0F2 at sunspot maximum shows the greatest rate of morning increase in July when f_0F2 attains an annual minimum, remains unexplained. (BBB)

11516 SOME EQUATORIAL IONOSPHERIC E- AND F- REGION DRIFTS MEASUREMENTS AT TAMALE. Koster, J. R.; Katsriku, I. K. (Univ. of Ghana, Legon). Ann. Geophys., 22: 440-7(July-Sept. 1966).

Parameters which describe the drift and anisometry of equatorial E- and F-region irregularities were deduced from analysis of spaced-received drift measurements obtained at Tamale, Ghana (geographic latitude 9°25′N, 0°53′W, magnetic dip 1°14′S). The spaced antenna technique was used and the records were analyzed by a full correlation method. The results showed that the drifts are westward during the day and eastward at night, reversal in direction occurring at about 07.30 and 20.00 hr GMT. A mid-morning maximum of about 200 m/sec was a prominent feature in the F-region drift velocity. The mean magnitude of the F-region drift velocity was 115 m/sec during the day and 70 m/sec at night, while in the E region the velocity was 67 m/sec by day. The correlation ellipses, which were elongated with axial ratios of the order of 6 : 1, were oriented along the earth's magnetic field lines. A study of the characteristic velocity, Vc, and the ratio V/Vc showed that significant random changes occur in the shape of the irregularities as they drift and that these random changes contribute to the fading of the signals. (BBB)

11517 CYCLOTRON-RESONANCE AMPLIFICATION OF VLF AND ULF WHISTLERS. Liemohn, Harold B. (Southwest Center for Advanced Studies, Dallas). J. Geophys. Res., 72: 39-55 (Jan. 1, 1967).

Electromagnetic signals that propagate through the magnetosphere exchange energy with nonthermal charged particles by the cyclotron-resonance mechanism. The interaction is due to a Doppler shift of the propagation frequency ω to the cyclotron frequency ω_c of the charged particle that allows the particle to resonate with the electromagnetic fields. The dominant exchange is between electrons around 1 keV and VLF whistlers that propagate in the right-hand mode and between protons around 1 keV and ULF whistlers (Pc 1 geomagnetic micropulsations) that propagate in the left-hand mode. The complex wave number $k(\omega) = k_r + ik_i$ for propagation in a hot uniform plasma parallel to a static magnetic field is assumed to describe whistler properties locally in the magnetosphere. The power transfer function $A(\omega)$, which relates the input and output power spectrums, is determined by the path integral of k_i along a geomagnetic flux tube. Spectrums of A for both VLF and ULF whistlers have been evaluated for a variety of energy and pitch-angle distributions of the form $E^{-n}\sin^m\alpha$. In general, A has an amplification maximum just below a sharp absorption cutoff, which is consistent with observations. The detailed input-output spectrums of whistlers that are necessary to test the theory are not available yet. When these spectrums are measured, this interaction may provide a possible method for mapping the phase space distribution of nonthermal particles in the magnetosphere. (auth)

11518 ON THE INTERPRETATION OF IONOSPHERIC RESONANCES STIMULATED BY ALOUETTE 1. Crawford, F. W.; Harp, R. S.; Mantei, T. D. (Stanford Univ., Calif.). J. Geophys. Res., 72: 57-68(Jan. 1, 1967).

Plasma ringing phenomena were excited by Alouette 1 and other ionosphere probes at the local electron plasma frequency, upper hybrid frequency, and cyclotron frequency harmonics. It is suggested that observation of this effect is closely linked to the fact that, near to these frequencies, the warm plasma electrostatic waves, which could normally carry the energy away, have near-zero group velocity. The energy consequently remains in the vicinity of the antenna and manifests itself in the ringing. This hypothesis may be verified by studies of the group delay of a wave packet propagating between two antennas. Theoretical predictions of such delay are presented and have been found to agree very closely with laboratory plasma measurements. The success of these studies suggests a powerful new diagnostic technique based on group delay measurement. Its applicability to ionospheric studies is examined, and it is concluded that the method should be readily usable to obtain plasma parameters with high accuracy. The method has the particular advantage that it is influenced very little by local plasma perturbations produced by the vehicle and antennas. (auth)

11519 LIMITING DAYTIME FLUX OF IONIZATION INTO THE PROTONOSPHERE. Geisler, J. E. (Univ. of Illinois, Urbana). J. Geophys. Res., 72: 81-5(Jan. 1, 1967).

Charge exchange between neutral atomic oxygen and hydrogen ions diffusing downward from the protonosphere provides a nocturnal source of ionization in the ionospheric F2 layer. The strength of this source depends ultimately on the rate at which hydrogen ions, created during the day by the charge exchange reaction in reverse, can diffuse upward to replenish the protonosphere. A treatment is presented of the upward diffusion problem that leads to an analytic expression for the maximum upward flux that can be supported by diffusion, showing explicitly the dependence of this quantity upon ionospheric and atmospheric parameters. (auth)

11520 MAGNETIC FLUCTUATIONS IN THE MAGNETOSHEATH: MARINER 4. Siscoe, G. L. (California Inst. of Tech., Pasadena); Davis, L. Jr.; Smith, E. J.; Coleman, P. J. Jr.; Jones, D. E. J. Geophys. Res., 72: 1-17(Jan. 1, 1967).

Mariner 4 magnetometer data obtained in the earth's magnetosheath are analyzed to determine the character of the fluctuations observed in the magnetic field. Spectral analysis and plots of smoothed data indicate a generally high level of activity in the hydromagnetic regime. Evidence for both compressional and torsional waves is presented. During a one-half hour interval while the spacecraft was near the magnetopause, a large-amplitude oscillation was observed with a period of approximately 200 seconds. It is shown that this oscillation is composed of longitudinal and transverse components. More generally, the hydromagnetic-wave energy density was greatest near the magnetopause and had an average value of 3×10^{-11} erg/cm^3 during the traversal of the magnetosheath by Mariner 4. The behavior of higher frequency fluctuations is inferred from 4.8-second standard deviations of both the absolute magnitude and one component of the field. Compressional fluctuations in the frequency range 0.2–1.0 cps were of roughly constant intensity throughout the magnetosheath, increasing only slightly near the shock. Transverse fluctuations were smaller near the magnetopause and increased greatly as the shock was approached. These data were obtained during a period of very low geomagnetic activity. The magnetosheath crossing occurred very nearly in the meridian plane at 0400 hours local time. (auth)

11521 INFLUENCE OF INTERPLANETARY MAGNETIC FIELD AND PLASMA ON GEOMAGNETIC ACTIVITY DURING

QUIET-SUN CONDITIONS. Wilcox, John M. (Univ. of California, Berkeley); Schatten, Kenneth H.; Ness, Norman F. J. Geophys. Res., 72: 19-26(Jan. 1, 1967).

Observations by the IMP 1 satellite of the interplanetary magnetic field and plasma were compared with the 3-hour geomagnetic activity index K_p. The average K_p is approximately a linear function of the interplanetary field magnitude B in gammas [$\overline{K}_p = (0.33 \pm 0.02)B \pm 0.2$]. It appears significant that this relation between $\overline{K}_p$ and field magnitude passes through the origin, whereas the linear relation between $\overline{K}_p$ and solar wind velocity does not. The average K_p is approximately a linear function of solar wind velocity, but with perhaps a slightly different slope and zero intercept from the similar relation observed by Snyder, Neugebauer, and Rao with Mariner 2. Little correlation is observed between $\overline{K}_p$ and solar wind density, but this result is consistent with the interplanetary sector pattern discussed by Wilcox and Ness. Cross-correlation as a function of time lag of K_p and interplanetary field (or solar wind velocity) yields a positive peak correlation at zero lag, suggesting that a large part of the response of the magnetosphere to solar wind excitation occurs within the 3-hour K_p period. (auth)

11522 VELA 3 SATELLITE OBSERVATIONS OF SOLAR WIND IONS: A PRELIMINARY REPORT. Hundhausen, A. J.; Asbridge, J. R.; Bame, S. J.; Gilbert, H. E.; Strong, I. B. (Los Alamos Scientific Lab., N. Mex.). J. Geophys. Res., 72: 87-100 (Jan. 1, 1967). (LA-DC-8118).

The electrostatic analyzers on the Vela 3 satellites measure the ion flux with high resolution in both energy and direction. From the measured fluxes are computed values of the velocity distribution function at points on a plane in velocity space. The function is extended over the whole plane by interpolation and displayed by a contour mapping in this plane. From this mapping the properties of the function can be visualized, and parameters characterizing the ion component of the plasma can be computed. The distribution functions of solar wind protons observed during the first month the satellites were in orbit are found to be significantly anisotropic in a frame of reference moving with the local plasma bulk velocity. A "tail" of protons with high random energies is usually present; evidence is presented that suggests that this tail is aligned with the interplanetary magnetic field lines, more often pointing away from the sun (along the lines) than toward the sun. The mean random energy or temperature of the protons is highest in this direction. The ratio of the maximum temperature to the average over-all directions ranges from 1.0 to about 2.5, with a value of 1.4 being most common. The existence of this anisotropy can be explained by the invariance of $v_\perp^2/B$ as the plasma expands from the sun. Similar anisotropic distribution functions are found for the He^{++} or α-particle component of the plasma. The ratio of number densities of the α's and protons is found to vary from 0.00 to 0.15, with a mean value of 0.042 during this period. (auth)

11523 VELA 2 MEASUREMENTS OF THE MAGNETOPAUSE AND BOW SHOCK POSITIONS. Gosling, J. T.; Asbridge, J. R.; Bame, S. J.; Strong, I. B. (Los Alamos Scientific Lab., N. Mex.). J. Geophys. Res., 72: 101-12(Jan. 1, 1967). (LA-DC-8000(Rev.)).

Extensive measurements of the positions of the earth's magnetopause and bow shock were performed with the Vela 2 satellites at ~17 R_E (earth radii) and at ecliptic latitudes up to ±63°. It was found that these positions are highly variable in time; there is evidence that some of this variability is due to the changing character of the solar wind. In particular, the average positions of the magnetopause and shock appear to be related to the magnetic disturbance index K_p and thus also to solar wind velocity. Specific examples of data were found that can be interpreted as showing gross motions of either the magnetopause or shock at times of sudden changes in plasma pressure within the magnetosheath. Despite the large variations in the magnetopause and shock positions, it was found that solar magnetospheric and solar ecliptic coordinates are both useful coordinate systems for ordering the boundary positions. However, solar magnetospheric coordinates appear to be slightly preferable at high latitudes. In either system, both the magnetopause and the shock exhibit an east-west tilt of about 2 to 4° relative to the sun-earth line. (auth)

11524 CHARACTERISTICS OF THE PLASMA SHEET IN THE EARTH'S MAGNETOTAIL. Bame, S. J.; Asbridge, J. R.; Felthauser, H. E.; Hones, E. W.; Strong, I. B. (Los Alamos Scientific Lab., N. Mex.). J. Geophys. Res., 72: 113-29(Jan. 1, 1967). (LA-DC-8098).

Vela satellite observations of electrons and protons with E > 100 eV show that a sheet of plasma with enhanced energy density stretches across the earth's magnetotail from the dusk to the dawn boundaries of the magnetosphere. The plasma was observed at geocentric distances between 15.5 and 20.5 earth radii; this plasma sheet probably extends from the night-side termination of the radiation belt to beyond 31 R_E in the antisolar direction. Near the midnight meridian at ~17 R_E the sheet is often ~4–6 R_E thick, while toward the dusk and dawn boundaries the sheet flares out to about twice that thickness. The plane of symmetry of the sheet lies above or below the solar magnetospheric equatorial plane depending on whether the geomagnetic dipole axis tilts toward or away from the sun. The plasma is located in the vicinity of the "neutral sheet" region of magnetic field reversal; inside the plasma sheet the measured kinetic energy densities of the electrons are comparable to the expected magnetic field energy densities, while outside the sheet the kinetic energy densities are much lower. The energy spectrums are quasi-thermal in character, having average energies extending from ~200 eV to above 12 keV; omnidirectional fluxes extend to above 10^9 cm^{-2} sec^{-1}. Both rapid (100–200 sec) and slower changes occur in the average energies of the plasma sheet electrons, resulting in large variations in the flux of energetic electrons (E > 45 keV). The plasma sheet boundaries, which are frequently in motion, are clearly defined by large changes in the electron flux. The average energy of the electron population is higher on the dawn side of the magnetotail than the dusk side, resulting in a more frequent appearance of energetic electrons on the dawn side. (auth)

11525 THE NEUTRAL SHEET IN THE GEOMAGNETIC TAIL: ITS MOTION, EQUIVALENT CURRENTS, AND FIELD LINE CONNECTION THROUGH IT. Speiser, T. W.; Ness, N. F. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 72: 131-41(Jan. 1, 1967).

From March 22 to May 26, 1964, during orbits 30 through 47, the IMP 1 satellite was located within the earth's magnetic tail, and measurements of the imbedded neutral sheet were possible. Forty-two observations of magnetic field reversals accompanied by a decrease in the field magnitude were detected. Of these, 38 are identified as crossings of a well-developed magnetic neutral sheet or current sheet. The relatively thin neutral sheet lies within a broad region of magnetic field depression and plasma enhancement, or "plasma sheet." The neutral sheet frequently appears to be moving relative to the satellite with a maximum velocity of a few kilometers per second, and on many orbits multiple crossings occur. The formation of the sheet appears to begin near the magnetic equatorial plane at a geocentric distance of 10 ± 3 R_E. The sheet thickness appears to be larger close to the earth and the dawn side of the tail and smaller farther away and toward the noon-midnight meridian. At its thinnest region the sheet appears to be about 500 km thick and about 5000 km at the thickest part. The normal component of magnetic field within the sheet appears from these measurements to be 1 to 4 gammas toward the dawn side of the tail and less than 1 gamma near the noon-midnight meridian plane. Thus the IMP 1 results favor those models of the tail field topology in which merging of field lines occurs across the imbedded neutral sheet. (auth)

11526 FINITE-β RESISTIVE INSTABILITIES OF MAGNETOSPHERIC TAILS. Rosenbluth, M. N.; Chang, D. B. (General Atomic Division, General Dynamics Corp., San Diego, Calif.). J. Geophys. Res., 72: 143-58(Jan. 1, 1967).

The decoupled-flow regions of resistive instabilities occurring in magnetospheric tails are sufficiently narrow that magnetic and collisional viscosities may be of importance. To determine the effects of these viscosities, the resistive instabilities studied in the hydromagnetic approximation by Furth, Killeen, and Rosenbluth and Johnson, Greene, and Coppi are studied with plasma equations based on the Chapman and Cowling expansion. Treating the ratio β of the plasma pressure to magnetic pressure to be of order unity, three cases are considered, two leading to tearing instabilities and the third giving a gravitational instability. It is found in all three cases that the hydromagnetic equations are applicable when the ion collision frequency is larger than the ion cyclotron frequency. When the ion cyclotron frequency exceeds the ion collision frequency, the results are qualitatively the same except that ion-ion collisions replace ion inertia in determining the growth rates and the size of the decoupled flow region. The conditions under which the Hall currents become important are defined. (auth)

11527 DISTORTION OF THE MAGNETOSPHERE DURING A MAGNETIC STORM ON SEPTEMBER 30, 1961. Cahill, L. J. Jr. (Univ. of California, San Diego, La Jolla); Bailey, D. H. J. Geophys. Res., 72: 159 69(Jan. 1, 1967).

A sudden commencement magnetic storm started on September 30, 1961. The Explorer 12 satellite was in orbit, in the day side of the magnetosphere, during the storm. During the recovery phase of the storm the field magnitude at 4 R_E (earth radii), and at magnetic latitudes above 20°, was increased. A low-latitude pass, late in the recovery phase, revealed a field depression at 4 R_E near the equator. The field distortions observed are attributed to inflation of the magnetosphere by low-energy charged particles on field lines from L = 2 to L = 5. (auth)

11528 MAGNETOPAUSE STRUCTURE AND ATTITUDE FROM EXPLORER 12 OBSERVATIONS. Sonnerup, B. U. O.

(Dartmouth Coll., Hanover, N. H.); Cahill, L. J. Jr. J. Geophys. Res., 72: 171-83(Jan. 1, 1967).

It is shown how satellite magnetometer data at a magnetopause penetration can be used to determine the vector normal to the magnetopause current layer and the magnetic-field component along this normal. According to theory such a component is a measure of the amount of field reconnection at magnetopause. Results from 22 Explorer 12 boundary penetrations are presented indicating normal-field components of less than 5 γ in two-thirds of the cases. Measured field variations within the current layer are presented to demonstrate the existence of two fundamentally different types of boundary structure, the rotational and the tangential discontinuity. The former of these permits a nonzero normal field component, whereas the latter does not. The rotational discontinuity seems to occur predominantly during magnetic storms and two of these cases, involving substantial normal-field components, provide compelling evidence that field reconnection takes place during the storm main phase. Finally, the calculated normal vector is compared with the normal to the surface of the Mead-Beard magnetosphere model. (auth)

11529 INITIAL OBSERVATIONS OF LOW-ENERGY ELECTRONS IN THE EARTH'S MAGNETOSPHERE WITH OGO 3. Frank, L. A. (Univ. of Iowa, Iowa City). J. Geophys. Res., 72: 185-95(Jan. 1, 1967).

Initial observations of electrons over the energy range extending from ~100 eV to 50 keV at geocentric radial distances 8 to 20 R_E in the dark hemisphere of the earth's magnetosphere with electrostatic analyzers borne on OGO 3 are presented for June 12–13, 1966. The electron differential energy spectrums typically are characterized by a single peak in intensities occurring in the energy range ~0.8–10 keV and at lower energies with increasing geocentric radial distance, by broader widths with decreasing radial distance, and by greater slopes for electron energies $E_e \geq 5$ keV with increasing radial distance. The radial profiles of unidirectional and omnidirectional, integral and differential intensities, and energy densities of electrons within the above energy range are characterized by catastrophic variations in magnitude that are presumably reflections of both temporal and spatial variations in intensities. Beyond ~13 R_E many electron spectrums are "monoenergetic" to the extent that $\gtrsim 75\%$ of the energy flux is shared among electrons in the energy range 1 to 3 keV, as an example, although measurable electron intensities are observed over the entire energy range ~400 eV to 50 keV. In contrast with the presistent softening of the electron spectrums with increasing radial distance between 8 and 20 R_E, the electron energy densities in the peaks of intensities do not show a marked radial dependence beyond ~13 R_E. The observed electron ($E_e > 280$ eV) energy densities in the peaks of the radial profiles almost always rise to ~10^{-9} erg/cm^3, an effect which may be indicative of an instability or "saturation" of the local magnetic field, and are significant in substantially distorting the geomagnetic field beyond ~8 R_E. Typical values of the ratios of intensities $J(E_e > 610 \text{ eV})/J(E_e > 45 \text{ keV})$ are 10^4 in the magnetospheric tail. The maximum temporal resolution of the apparatus is ~100 msec: temporal variations of low-energy electron intensities by factors $\gtrsim 2$ occurred usually in periods ~seconds to several minutes. (auth)

11530 INFLUENCE OF THE GEOMAGNETIC TAIL ON LOW ENERGY COSMIC-RAY CUTOFFS. Reid, G. C.; Sauer, H. H. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). J. Geophys. Res., 72: 197-208(Jan. 1, 1967).

It has been known for several years that geomagnetic cutoffs for low-energy solar protons are anomalously low, even during periods of low geomagnetic activity. Several independent groups of measurements of cutoffs have been obtained by satellites and are in general agreement with the results of more indirect measurements of polar-cap absorption by riometers. The "midday recovery" phenomenon observed by riometers near the low-latitude edge of polar-cap absorption has been interpreted as the result of a diurnal variation in local cutoff. Attempts are made to relate the depression of low-energy cutoffs to the permanent existence of a geomagnetic tail, and an approximate model calculation of cutoffs in the presence of the tail indicates that both the permanent depression of cutoffs and the PCA midday recovery can be satisfactorily explained quantitatively on this basis. It is suggested that the midday recovery phenomenon is intimately related to the pronounced diurnal variation in the boundary of the stable trapping region for energetic electrons in the geomagnetic field. (auth)

11531 IONOSPHERIC DISTURBANCE AND ELECTRON PRECIPITATION FROM THE OUTER RADIATION BELT. Gledhill, J. A.; Torr, D. G.; Torr, Marsha R. (Rhodes Univ., Grahamstown, S. Africa). J. Geophys. Res., 72: 209-14(Jan. 1, 1967).

Values of precipitated electron flux near the magnetic shell L = 4, observed by the satellite Alouette, are compared with ionospheric behavior at six stations that also lie near this shell. It is shown that there exists a critical value of the flux, the same for all stations, above which an ionospheric disturbance invariably occurs. These disturbances involve increased absorption in the D and lower E regions, with usually a decrease of f_0F_2 and an increase of $h'F_2$. It is further shown that the percentage of time for which the critical flux is exceeded at each station is almost exactly the same as the percentage of time for which the ionosphere is disturbed. The conclusion is drawn that all such disturbances can be accounted for by electron precipitation. (auth)

11532 SPATIAL CHARACTERISTICS OF AURORAL-ZONE X-RAY MICROBURSTS. Parks, George K. (Univ. of California, Berkeley). J. Geophys. Res., 72: 215-26(Jan. 1, 1967).

An array of four narrowly collimated X-ray detectors, each viewing a separate part of the sky, was used to study spatial and temporal characteristics of bremsstrahlung X rays produced by energetic electron precipitation in the auroral zone. Each telescope viewed a circle of about 20-km diameter at the stopping heights of electrons (90–100 km). The telescope arrays were carried to small atmospheric depths of 2 to 3 g/cm^2 using large-volume balloons. The data revealed that the impulsive-type energetic electron precipitation events, microbursts, are not distributed uniformly in the X-ray production plane. The data further showed that each microburst precipitation region is on the average 40 ± 14-km radius. An energetic electron precipitation event that occurred on September 16, 1965, was shaped similarly to bands aligned in the north-south direction drifting eastward with a velocity of about 250 to 300 m/sec. Microbursts occurred during this event, indicating that the propagating electron source region and microbursts were related. (auth)

11533 SATELLITE MEASUREMENTS OF PRECIPITATING PROTONS IN THE AURORAL ZONE. Sharp, R. D.; Johnson, R. G.; Shea, M. F.; Shook, G. B. (Lockheed Missiles and Space Co., Palo Alto, Calif.). J. Geophys. Res., 72: 227-37(Jan. 1, 1967).

A worldwide survey of precipitating low-energy protons was made during a magnetically quiet 2½-day period in November 1965. Several of the particle detectors abroad a low-altitude, polar-orbiting satellite measured protons above thresholds of approximately 10, 21, 38, and 56 keV. Data were obtained from two types of instruments: plastic scintillators on photomultipliers with foil-determined thresholds at 10 and 57 keV; and channel multipliers with foil-determined thresholds at 21, 38, and 56 keV. Precipitating proton fluxes were observed on traversals of both the northern and southern auroral zones. The maximum flux of precipitating protons observed was 0.3 erg/cm^2 sec. A preliminary analysis at the positions of the peaks resulted in spectrums that were generally consistent with an exponential number flux shape with characteristic energies that were usually in the range 10 to 20 keV, and in angular distributions that were consistent with isotropy over the loss cone within about a factor of 2. Evidence of two distinct zones of precipitation on the day side has been obtained. The median peak intensity near local midnight was about a factor of 5 greater than at local times near noon. (auth)

11534 CRITICAL EXAMINATION OF A THEORY OF AURORAL ELECTROJETS. Gottlieb, B.; Fejer, J. A. (Southwest Center for Advanced Studies, Dallas). J. Geophys. Res., 72: 239-44(Jan. 1, 1967).

A charge separation mechanism previously suggested for the explanation of auroral electrojets is critically examined. It is assumed that near the auroral zone the ionospheric conductivity is enhanced by electron bombardment and that those presently unknown energetic trapped protons whose energies are below the Explorer 12 counter threshold must also be considered. Computations of the current system are carried out for different assumed latitude distributions of the trapped particles and of the enhanced conductivity. It is demonstrated that large electrojet currents responsible for magnetic disturbances of the order of 1000 γ result only if the assumed conductivity enhancement extends over a much wider range of latitudes than that occupied by the assumed trapped particles. (auth)

11535 THE STATISTICAL AURORAL ZONE DURING IQSY AND ITS RELATIONSHIP TO MAGNETIC ACTIVITY. Stringer, W. J.; Belon, A. E. (Univ. of Alaska, College). J. Geophys. Res., 72: 245-50(Jan. 1, 1967).

The several criteria that have been used for a determination of the statistical auroral zone are reviewed. It is seen that quite different criteria have given the same all-time statistical location of maximum auroral activity. The criterion of auroral incidence has been used to analyze all-sky camera data for the year 1964–1965. The relationship between auroral incidence and magnetic activity is such that when the K index from magnetic observatories in the auroral zone is zero, auroral incidence maximizes at latitudes greater than dp 70°N. As the K index increases, the peak of auroral

incidence moves rapidly southward. The low-latitude part of the incidence profile becomes steeper as K increases, while the high-latitude portion always exhibits a gradual decrease toward high latitudes. The results of this study indicate that it is possible to synthesize the IQSY auroral incidence profile on the basis of magnetic activity and therefore, independently of seeing conditions. Comparison of IGY and IQSY auroral profiles of incidence versus dp latitudes shows that the dp latitude of peak incidence (dp 66.5°) did not change during this period. The profiles are different in form, however. To the south of the incidence peak the IQSY profile converges to zero incidence at dp 62°, while the IGY profile shows a relative incidence of 20% at this latitude, and to the north of the incidence peak, the IQSY profile shows higher relative incidence than the IGY profile. (auth)

11536 CHARACTERISTIC HEIGHTS FOR HYDROMAGNETIC PROCESSES IN THE ATMOSPHERE. Poeverlein, H. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Geophys. Res., 72: 251-6(Jan. 1, 1967).

Slow hydromagnetic processes (nonperiodic or periodic with periods up to one day) assume a different character in different height intervals of the ionosphere and magnetosphere. The boundaries of these intervals and the apparent bottom of the hydromagnetic region are referred to as "characteristic heights." They are determined by simple relationships involving the cyclotron frequency of ions, the gravity acceleration, collision frequencies, and Alfvén and sound velocities. Convergence or divergence of plasma motions, current flow, and a transition between different stratifications of the plasma density can be expected at some characteristic heights. (auth)

11537 IONOSPHERIC HEATING ASSOCIATED WITH THE MAIN-PHASE RING CURRENT. Cummings, W. D.; Dessler, A. J. (Rice Univ., Houston, Tex.). J. Geophys. Res., 72: 257-63(Jan. 1, 1967).

Heating caused by an asymmetry in the main-phase ring current belt is examined. The heating mechanism is the joule dissipation of the ionospheric current system associated with the asymmetry. The energy dissipated in the ionosphere, coming from the particle energy contained in the asymmetry, is at a maximum during the main and early recovery phases of a geomagnetic storm. This heating should have a local-time dependence that produces maximum heating near 1800 hours local time. The consequences of a flute (or interchange) instability in the main-phase ring current plasma are also discussed, with particular attention given to the joule heating of the stabilizing currents that flow in the ionosphere. It is concluded that this heating mechanism could deposit enough heat into the ionosphere during a magnetic storm to compete with the normal solar ultraviolet heat input and thus contribute to storm-correlated increases in satellite drag. (auth)

11538 GLOBAL BEHAVIOR OF THE IONOSPHERE AT 1000-KILOMETER ALTITUDE. Brace, L. H.; Reddy, B. M.; Mayr, H. G. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 72: 265-83(Jan. 1, 1967).

Explorer 22 electrostatic probe measurements of electron temperature (T_e) and concentration (N_e) at the 1000-km level during the period from November, 1964 to May, 1965, are presented and discussed. Precession of the orbital plane during this period has permitted the resolution of two full diurnal cycles of ionospheric behavior at this altitude, one centered on the winter solstice and one on the vernal equinox. In both seasons, the latitudinal distributions of N_e and T_e reveal a diurnal modulation at middle and low latitudes that appears consistent with a mechanism of thermal expansion and contraction of the protonosphere along the geomagnetic field lines. Although there is a strong tendency toward symmetry about the magnetic equator, an important seasonal effect is evident as an enchancement of N_e throughout the summer hemisphere. Interpretation of the equatorial measurements in terms of the processes of photoelectron heating, local cooling via ions to neutrals, and electron thermal conduction permits the conclusions that: (1) diffusive equilibrium exists in the equatorial protonosphere, even at sunrise and sunset; (2) the observed latitudinal distributions of T_e and N_e near the equator are mutually consistent with diffusive equilibrium, both day and night; and (3) a local electron cooling exists in the equatorial region that is inconsistent with present neutral atmosphere models but suggests the existence of about 5×10^5 cm^{-3} atoms of neutral hydrogen at 1000 km. (auth)

11539 TRAVELING IONOSPHERIC DISTURBANCES ASSOCIATED WITH NUCLEAR DETONATIONS. Breitling, W. J. (Avco Corp., Wilmington, Mass.); Kupferman, R. A.; Gassmann, G. J. J. Geophys. Res., 72: 307-15(Jan. 1, 1967).

The analysis of ionospheric data taken from 54 ionosonde observatories throughout the world indicates the presence of several traveling ionospheric disturbances originating from the five high-altitude nuclear tests conducted over Johnston Island in 1962. These disturbances were propagated over large distances and were observed as changes in the F2-layer critical frequency. They are interpreted as a series of waves that are propagated at various velocities. Travel time curves are presented indicating dispersion and a range of velocities from 50 to 900 m/sec. (auth)

11540 GEOMAGNETIC FLUCTUATIONS DUE TO IMPULSE SOURCES WITH APPLICATIONS TO HIGH-ALTITUDE NUCLEAR BURSTS. Field, E. C.; Greifinger, C. (Rand Corp., Santa Monica, Calif.). J. Geophys. Res., 72: 317-29(Jan. 1, 1967).

The response of the ionosphere-exosphere system to a bomb-like hydromagnetic source and the resultant time-dependent ground-level magnetic fluctuations are examined theoretically, with emphasis placed upon gaining an understanding of the time behavior of the ground-level signal. The methods of calculation are also applicable to certain magnetic fluctuations of natural origin. An analytic treatment is used, whereby the problem is reduced essentially to finding the poles and residues of previously derived hydromagnetic transmission coefficients. Conditions corresponding to high magnetic latitudes are used, but some conclusions corresponding to more general conditions are drawn. Bomb-induced ground-level magnetic fluctuations are interpreted in terms of a croadband excitation of ionospheric and exospheric resonant oscillations. Even for broadband sources, which excite all of the many resonances, the signal rapidly becomes dominated by the lowest characteristic frequencies. Thus, for a wide range of source functions, the frequency content of the transmitted signal would be determined largely by the resonant properties of the propagation medium. Two examples of this are the magnetic fluctuations measured after the Argus and Starfish high-altitude nuclear tests. For hypothetical high-latitude bursts detonated in or above the lower ionosphere, the ground-level signal is predicted to be nearly left-hand circularly polarized in the daytime and to exhibit nearly the polarization of the source at night. For many situations of practical interest, the enhancement of the lower ionospheric ionization density by bomb X rays is a very important consideration. (auth)

11541 CORRELATION BETWEEN OCCURRENCE OF PEARL PULSATIONS AND INTERPLANETARY MAGNETIC FIELD SECTOR BOUNDARIES. McPherron, R. L.; Ward, S. H. (Univ. of California, Berkeley). J. Geophys. Res., 72: 393-8(Jan. 1, 1967).

A significant correlation between the occurrence of pearl pulsations at College, Alaska, and interplanetary magnetic field sector boundaries has been observed. Pearl pulsation data published by the Geophysical Institute, University of Alaska, and sector data published by Wilcox and Ness have been used to show the following: pearl pulsations are more likely to occur on the day a sector boundary passes the earth than in the middle of a sector. Pearl pulsations occur with maximum probability near 1500 local time on all sector days but are restricted almost entirely to local afternoon in the middle of a sector. On the average, fewer pearl pulsations are observed during magnetically disturbed times than quiet times, but in the afternoon pearl occurrence is enhanced by geomagnetic disturbance. Pearls begin and end later in the day as the level of magnetic activity increases. (auth)

11542 EVENING MICROPULSATION EVENTS WITH A RISING MIDFREQUENCY CHARACTERISTIC. Heacock, R. R. (Univ. of Alaska, College). J. Geophys. Res., 72: 399-408 (Jan. 1, 1967).

Many examples of evening micropulsation events with rising midfrequencies were found on the several years of continuous College micropulsation records. The midfrequency typically rises from 0.1 to 0.5 cps over a ~1-hour event duration. There is a pronounced diurnal variation in occurrence, with maximum near 2000 local time, and there is a seasonal variation with most occurrences in summer. Three of the possible source mechanisms are briefly discussed: (1) systematic variations in the characteristics of the lower exosphere resonance cavity, (2) excitation via a growing wave mechanism with the additional assumption of a time-decreasing midenergy in the electron or proton beam, and (3) excitation via proton cyclotron instabilities near the equatorial plane with inward diffusion of the protons. (auth)

11543 IONOSPHERIC STABILIZATION OF THE INTERCHANGE MODE. Pearlstein, L. D. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Geophys. Res., 72: 409-13(Jan. 1, 1967).

To pursue a stability analysis of particles trapped in the radiation belt, the stabilizing influence of ionospheric currents is discussed. Previous calculations [Chang et al.] treat this problem, and the results are applied to the electron debris of the Starfish Burst where the distribution is represented by a fission fragment energy spectrum with a phenomenologic fit to the spatial dependence. The results of these calculations show that with daytime ionospheric parameters line tying, the effect of the ionospheric currents, stabilizes the interchange mode. For nighttime iono-

spheric parameters, where values are more sporadic, and with the initial density of trapped electrons, the stability criterion is violated by an order of magnitude for the more extreme data. (J.H.M.)

11544 DIRECT CORRESPONDENCE BETWEEN X-RAY MICROBURSTS AND IMPULSIVE MICROPULSATIONS. Milton, D. W.; McPherron, R. L.; Anderson, K. A.; Ward, S. H. (Univ. of California, Berkeley). J. Geophys. Res., 72: 414-17(Jan. 1, 1967).

Experimental work was done in 1965 with an improved magnetic micropulsation apparatus having high frequency response up to 2 cycles per second. At that time a series of impulsive micropulsations were seen that were in one-to-one correspondence with a series of x-ray microbursts being observed simultaneously with a balloon detector. The results of this experiment are discussed. (J.H.M.)

11545 NOTE ON OSCILLATING FIELD LINES. Radoski, Henry R. (Boston Coll., Weston, Mass.). J. Geophys. Res., 72: 418-19(Jan. 1, 1967).

The concept of vibrating field lines to explain micropulsation observations was discussed by Wilson, 1966. The equations governing this phenomenon are examined to ascertain the mathematical reliability of such a physical model. It is the contention that, while there is no valid theoretical demonstration that permits the oscillation of individual field lines, there are strong theoretical reasons against such an occurrence. The basic wave equation describing low-frequency propagation in a magnetized plasma is given. (J.H.M.)

11546 EVIDENCE FOR THE INFLUENCE OF ATMOSPHERIC WAVES ON IONOSPHERIC MOTIONS. Georges, T. M. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). J. Geophys. Res., 72: 422-5(Jan. 1, 1967).

Ionospheric motions observed with a vertical-incidence cw Doppler (phase-path) sounder are analyzed with regard to spectral characteristics and for examples of nearly sinusoidal motions. The motions of concern are those responsible for the continuous and random frequency fluctuations characteristic of quiet periods when solar and magnetic activity are negligible. (J.H.M.)

11547 MAGNETOSHEATH FIELD, GEOMAGNETIC INDEX a_p AND STABILITY OF MAGNETOPAUSE. Patel, V. L.; Cahill, L. J. Jr.; Dessler, A. J. (Rice Univ., Houston, Tex.). J. Geophys. Res., 72: 426-30(Jan. 1, 1967).

Explorer 12 magnetic field observations are used to study the effect of the magnitude and direction of the field in the region immediately outside the magnetosphere (the magnetosheath) on fluctuations in the field at ground level as measured by the K_p or a_p indexes. (J.H.M.)

11548 MAGNETODYNAMICALLY INDUCED AMBIGUITY IN THE DATA FROM TILTED, SPINNING FLUXGATE MAGNETOMETERS: POSSIBLE APPLICATION TO IMP 1. Fredricks, R. W. (TRW Systems, Redondo Beach, Calif.); Greenstadt, E. W.; Sonett, C. P. J. Geophys. Res., 72: 367-82(Jan. 1, 1967).

Data from a satellite-borne, tilted, spinning fluxgate magnetometer are subject to inherent ambiguities when the sampled ambient field is dynamically active. These ambiguities are further compounded when the sampling is multirate. The intrinsic limitations of a multirate-sampled, tilted fluxgate system are described, the production of false ambient vectors is explained, and the conditions for extracting desired physical quantities, such as field magnitudes and power spectra, are discussed. The results are applied to the Explorer 18 (IMP 1) magnetometer system in the magnetosheath, and it is shown that the ambiguities of the system may in fact limit the interpretability of the Explorer 18 data in some parts of this region or in other regions of magnetic activity. Discussions are included on the relevance of dynamic field effects to magnetosheath boundary determinations, to the interpretations of Explorer 18's magnetosheath data as "turbulent" fields, and to the apparent differences between Explorer 18's magnetosheath measurements and those obtained by magnetometers aboard other spacecraft such as Pioneer 1, OGO 1, and Vela 3. (auth)

11549 INTERPRETATION OF THE FIRST-ORDER CORRECTION TO THE MAGNETIC MOMENT INVARIANT. Ball, R. H. (Rand Corp., Santa Monica, Calif.). J. Geophys. Res., 72: 436-7(Jan. 1, 1967).

In the study of the permanence and stability of the Van Allen radiation belts and in studies of mirror machines, it is important to understand the nature and behavior of the adiabatic invariants of the partial motion. Equations are shown to express the first-order correction to the magnetic moment or first adiabatic invariant. (J.H.M.)

11550 IONOSPHERIC RESEARCH. Maeda, Ken-Ichi. pp 199-238 of Science in Japan. Livermore, A. H. (ed.). Washington, D. C.; American Association for the Advancement of Science, 1965.

Ionospheric research carried out in Japan is surveyed. A brief outline is given of the organization of ionospheric research in Japan and of activities during the IGY and IGC. The results of research on the formation and electrodynamics of the ionosphere, ionospheric turbulence and scattering, radio-wave propagation, the world-wide distribution of f_0F2, disturbances associated with geomagnetic storms, polar blackouts, the distribution of the sporadic E layer, F1.5 layer, and spread F, the spiral pattern of aeronomical disturbance, the ionospheric tide, and solar eclipses are cited, as well as the results of Antarctic research expeditions and of research with the aid of sounding rockets and artificial satellites. (Int. Aero. Abstr.)

Low-Temperature Physics

Refer also to abstracts 11223 and 11304.

11551 (N-66-20038) CRITICAL CURRENT DEGRADATION IN WIDE SAMPLES OF HIGH-FIELD STRIP SUPERCONDUCTORS. Hoag, Ethan D. (Avco-Everett Research Lab., Everett, Mass.). June 1965. Contract NAS8-5279. 13p. (NASA-CR-70861; AMP-163). CFSTI $3.00 cy, $0.65 mn.

Measurements of the magnetic anisotropy of critical current in samples wide enough for use in large magnets reveal a degradation effect in strip superconductors. The effect is manifested as a truncation of the peaks of the anisotropy curves of these samples. With narrow samples the anisotropy curves, i.e., average critical current density plotted as a function of magnetic field direction, normally display a well-defined peak centered about the direction parallel to the rolling plane of the strip. With wide samples, however, this peak appears progressively more truncated as the width is increased, and the truncation level, i.e., maximum current density, is roughly inversely proportional to the width, so that the total current tends to remain constant, independent of width. For Nb-25% Zr strip 0.051 mm thick, this limiting current is approximately 125 Å at a field of 4 Wb/m^2 for widths between 1 and 10 mm. Samples 1.32 mm wide display little or no truncation and have maximum current densities of 1.8×10^5 A/cm^2, whereas 10 mm wide samples show severe truncation and have maximum current densities of 2.6×10^4 A/cm^2. (auth)

11552 (NASA-TN-D-3817) ULTRASONIC ATTENUATION IN SUPERCONDUCTING NIOBIUM. Simmons, Joseph H. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). June 1966. 24p. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The attenuation of ultrasonic waves with frequencies between 30 and 330 MHz was investigated in niobium single crystals oriented in the (100) and (110) crystal directions. The dependence of the attenuation on temperature was observed with the samples in different background magnetic fields, and the temperature-dependence energy gap was calculated from the observed attenuation by using the Bardeen-Cooper-Schrieffer model. The experiment was performed on both annealed and unannealed niobium single crystals. Both longitudinal and shear waves were used. The study of longitudinal waves led to a determination of the anisotropy of the zero-temperature energy gap. (auth)

11553 (NP-16506) CRITICAL FIELD OF SUPERCONDUCTING ALUMINUM AS A FUNCTION OF PRESSURE AND TEMPERATURE ABOVE 0.3 DEG K. Harris, Erik Preston (Illinois Univ., Urbana. Dept. of Physics). Nov. 1966. 110p.

The critical field curve of aluminum has been measured from T_c to 0.3°K, at pressures ranging from 0 to 7200 psi. Using calorimetrically derived values for the low-temperature superconducting electronic specific heat, the data have been extrapolated to T = 0, yielding values for H_o and γ. These values and experimental results for T_c are then used to calculate the superconducting electronic entropy and the deviation of the critical field curve from parabolicity over the entire temperature range. The results show excellent agreement with previous calorimetric measurements of the thermodynamic properties of superconducting aluminum. The shape of the reduced critical field curve shows no pressure dependence over the range of pressures used. The dependence of H_o, T_c, and γ on pressure are in fair agreement with previous work by Gross and Olsen. (auth)

11554 TUNNELING INVESTIGATION OF ENERGY-GAP ANISOTROPY IN SUPERCONDUCTORS. Campbell, C. K. (McMaster Univ., Hamilton, Ont.); Walmsley, D. G. Can. J. Phys., 45: 159-77(Jan. 1967).

Tunneling measurements of the energy gaps at $T \approx 1.2$°K in thick ($d \gtrsim \xi_0$) and thin ($d \ll \xi_0$) films of aluminum, lead, indium, and tin are reported. The thin films have isotropic gaps consistent

with the Anderson theory of dirty superconductors; the thick films all exhibit behavior that may be interpreted as due to the existence of multiple gaps. (auth)

11555 EFFECT OF RESONANCE SCATTERING ON THE CRITICAL TEMPERATURE OF ANISOTROPIC SUPERCONDUCTORS. Zuckermann, M. J. (Univ. of Virginia, Charlottesville); Singh, A. D. Can. J. Phys., 45: 37-45(Jan. 1967).

In a previous investigation, the effect of a nonmagnetic resonant d orbital (bound to a transition-metal impurity) on a simple isotropic superconductor was discussed. It was shown that the critical temperature T_c of such an alloy suffered an initial linear decrease proportional to the impurity concentration N_I. The resulting curve of T_c versus N_I remains linear for experimentally realizable values of the impurity concentration. This is not borne out experimentally, and one reason for the discrepancy is that the anisotropy of the superconductor was not taken into account theoretically. It is shown that the change in T_c due to the presence of nonmagnetic transition-metal impurities is given by the sum of three terms, as follows: (a) the isotropic term due to the interaction of the d orbital with the conduction electrons found in the previous investigation, (b) the usual term due to the "anisotropic effect" of Markowitz and Kadanoff (1963), and (c) a cross term between the resonance scattering and the anisotropic scattering. The term (c) is shown to be very small compared with (a) and (b) and hence the procedure for comparison with experiment used by Boato et al. (1966) is justified in the approximation. (auth)

11556 RESISTANCE IN THE MIXED STATE OF TYPE-II SUPERCONDUCTORS. Willis, J. S.; Schenck, J. F.; Shaw, R. W. (Rensselaer Polytechnic Inst., Troy, N. Y.). Appl. Phys. Lett., 10: 101-3(Feb. 1, 1967).

A mechanism is proposed for pinning of fluxoids by spatial inhomogeneities in the Ginzburg–Landau kappa parameter of a material. This is applied to resistive data from Tl–Pb and Pb–In alloys. (auth)

11557 OBSERVATION OF TRANSIENT FLUX MOTION IN Sn FILMS. Stewart, W. C.; Cosentino, L. S. (RCA Labs., Princeton, N. J.). Appl. Phys. Lett., 10: 88-91(Feb. 1, 1967).

Cumulative flux transport across a tin film carrying direct current is observed in pulsed magnetic fields of alternating polarity by direct detection of the generated emf and by buildup of trapped flux in a coupled superconducting loop. (auth)

11558 PROGRESS IN SUPERCONDUCTIVITY. Volger, J. (Philips Research Labs., Eindhoven, Netherlands). IEEE (Inst. Elec. Electron. Eng.) Trans. Magnet., MAG-2: 159-64(Sept. 1966).

A discussion of some recent developments related mainly to induction phenomena in superconductors is presented, with emphasis on the concept that superconductors are in a quantum state, extending over macroscopic distances, consequently trapping magnetic flux in multiples of the flux quantum. In superconductors of the second kind magnetic flux penetrates at external magnetic field values within a certain interval (mixed state). This state violates the traditional characteristics of superconductivity. Not only does it fail to show the perfect Meissner diamagnetism, but it is also, in principle, a resistive state. The latter feature is correlated with the instability of the magnetic structure in the mixed state when a current is injected, the induced flux flow phenomenon being responsible for a variety of effects recently studied, including the Hall effect and a mode of magnetic coupling which makes a dc transformer feasible. Superconductors of the second kind may obtain excellent current-carrying capacities if the mixed state magnetic pattern is stabilized, or pinned. Manufacture of some practicable wires and cables and the problems of coil construction and their stabilization are also surveyed. By proper manipulation of magnetic flux in superconducting systems, electromagnetic induction of heavy direct currents may be achieved. Fully superconducting dc generators or dynamos which have recently been developed are discussed, and some results of the author's recent investigations are given, including those on multikiloampere dynamos for energizing supermagnets. (BBB)

11559 MAGNETS FOR FIELDS ABOVE 100 kG. Montgomery, D. Bruce (Massachusetts Inst. of Tech., Cambridge). IEEE (Inst. Elec. Electron. Eng.) Trans. Magnet., MAG-2: 154-8(Sept. 1966).

The general techniques of field generation beyond 100 kG, represented by pulse, water-cooled direct current, and superconducting magnets, are presented. Conventional dc magnets are discussed first because they have been the most successful methods of generating a useful high-field environment and to show the level of investment necessary and the flexibility of the technique. The superconductor types are then discussed. It is suggested that classifying coils above and below 100 kG does not separate types or methods, but rather indicates the degree of difficulty. It is no longer true that conventional dc fields above 100 kG require larger than existing or contemplated power supplies, and it has been established that superconducting materials will be suitable for fields approaching twice that field. Problem areas, economics, and experience above 100 kG are discussed in 3 major areas: (1) water-cooled dc magnets, principally those now in operation at the National Magnet Laboratory; (2) pulse magnets covering the continuum from submillisecond pulses to the low-duty cycle cryogenic magnet systems; (3) superconducting magnets with emphasis on hybrid systems, combining water-cooled copper magnets and superconducting coils. (BBB)

11560 CONTRIBUTION OF THE ELECTRON–PHONON INTERACTION TO THE EFFECTIVE MASS, SUPERCONDUCTING TRANSITION TEMPERATURE, AND THE RESISTIVITY IN ALUMINIUM. Pytte, E. (Oslo Univ.). J. Phys. Chem. Solids, 28: 93-104(Jan. 1967).

The contribution of the electron–phonon interaction to the effective mass, the superconducting transition temperature and the dc resistivity has been calculated for aluminum using two different effective potentials. The conduction electrons were described by two orthogonalized plane waves, and the distortion of the Fermi surface near the zone boundaries was taken into account in an approximate way. The experimental phonon dispersion curves were used. For the potential constructed by Ashcroft, agreement with experiment to better than 10% was found for the effective mass and the parameter NV, determining the transition temperature, while the resistivity at 300°K was too low by about 25%. The pseudopotential constructed by Harrison gave too large values for all three quantities, by as much as 45% for the resistivity at 300°K. Using the Ashcroft potential, the resistivity was calculated for temperatures from 10°K to 900°K. In this calculation it was important to include the temperature dependence of the phonon spectrum. (auth)

11561 EFFECT OF PARAMAGNETIC IMPURITIES ON THE SUPERCONDUCTING BEHAVIOR OF CUBIC MOLYBDENUM CARBIDE. Willens, R. H.; Buehler, E. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 38: 405-6(Jan. 1967).

MoC rapidly quenched from melt has a superconducting transition temperature of 14.3°K. The substitutional addition of Fe, Cr, and Mn carbides for MoC resulted in a rapid decrease of the superconducting transition temperature, but at larger additions of Cr and Fe, the decrease rate was reduced. There is evidence for a stronger paramagnetic effect or local moment ordering at the higher additions. Two possible reasons for the reduction of the decrease rate are discussed: clustering of impurities, and spin-orbit effects. (D.L.C.)

11562 EXPERIMENTAL TESTS OF THE CRITICAL-STATE MODEL FOR HYSTERETIC SUPERCONDUCTORS. Schweitzer, Donald G.; Garber, M. (Brookhaven National Lab., Upton, N. Y.). Contract AT-(30-2)-Gen-16. Phys. Rev. Lett., 18: 206-9(Feb. 6, 1967). (BNL-10749).

New types of experiments which provide direct checks of the critical-state model of hysteresis in type-II superconductors are described. The observed behavior cannot be accounted for by the critical-state concept. (auth)

11563 ENERGY-GAP MEASUREMENTS IN TYPE-II SUPERCONDUCTORS BY A NEW METHOD. Sullivan, D. B.; Roos, C. E. (Vanderbilt Univ., Nashville). Phys. Rev. Lett., 18: 212-15(Feb. 6, 1967).

Current-voltage characteristics are presented for pressure contacts between type-II superconductors and normal metals. The characteristics are studied as a function of temperature and magnetic field. A simple model of the phenomenon indicates that, under suitable conditions, a measure of the energy gap at the boundary can be obtained directly from the I-V characteristics. (auth)

11564 SUPERCONDUCTIVITY OF CUBIC NIOBIUM CARBONITRIDES. Williams, M. W.; Ralls, K. M.; Pickus, M. R. (Univ. of California, Berkeley). J. Phys. Chem. Solids, 28: 333-41(Feb. 1967). (UCRL-16872(Rev.)).

An investigation has been made of the superconductive properties of the niobium–carbon–nitrogen ternary system. These compounds always show a range of composition, and previous investigators have often neglected the effect of stoichiometry. Both critical temperature (T_c) and upper critical field (H_{c2}) are dependent on composition, although not in the same way. The trend of H_{c2} at 4.2°K with decreasing nitrogen content is always down. The maximum T_c (17.8°K) occurs for nearly stoichiometric compounds having a C/Nb ratio of about 0.3. The critical temperature of substoichiometric NbN, which contains a small amount of carbon rather than the more common impurity oxygen, is 17.2 to 17.3°K. (auth)

11565 ON THE JOSEPHSON EFFECT IN HELIUM II. Mamaladze, Yu. G.; Cheishvili, O. D. Zh. Eksp. Teor. Fiz., 52: 182-4(Jan. 1967). (In Russian).

The phenomenological superfluidity theory is employed for investigating the flow of superfluid helium in narrow gaps with dimensions of the order or smaller than the critical ones. (auth)

11566 SUPERCONDUCTING PROPERTIES OF ALUMINUM FILMS. Alekseevskii, N. E.; Mikheeva, M. N. Zh. Eksp. Teor. Fiz., 52: 40-1(Jan. 1967). (In Russian).

The superconducting properties of Al films precipitated at liquid nitrogen temperature and then annealed to room temperature are investigated. The experiments indicate that the high critical temperatures of thin Al films apparently cannot be the result of formation of an oxide layer on their surface. (auth)

11567 STATISTICAL THERMODYNAMICS OF λ TRANSITIONS, ESPECIALLY OF LIQUID HELIUM. Rice, O. K. (Univ. of North Carolina, Chapel Hill). Phys. Rev., 153: 275-9(Jan. 5, 1967).

The thermodynamic properties of systems in the immediate neighborhood of a locus of λ transitions have been investigated. It is assumed that the transitions arise from spin orientation (or some other order–disorder phenomenon), and that the partition function can be broken down into a product of a lattice part and a spin part, the latter dependent only on $I = J/kT$, where J is an energy parameter. If J depends only on the volume V, then the specific heat at constant volume C_V tends to become infinite along the λ line, but as is well known, an instability sets in before this point is reached. It is shown that this instability occurs very close to the λ line, and C_V and $(\partial P/\partial T)_V$ may be expected to parallel each other much farther from the λ line. If an intrinsic volume change is associated with the ordering phenomenon, J is more appropriately taken as an enthalpy parameter, and may be supposed to depend on the pressure P rather than on V. Isothermal–isobaric partition functions are used. C_p tends to become infinite and to parallel $(\partial V/\partial T)_P$ a considerable distance from the λ line. Only very close to the λ line does $(\partial V/\partial P)_T$ become negatively infinite. The results are applied to liquid helium under pressure, and shown to accord with the data. The behavior of C_v is discussed. A possible generalization of the theory is suggested. (auth)

11568 INHIBITION OF THE SCINTILLATION OF STATIONARY AND ROTATING He II. Agee, Forrest J. Jr.; Manning, Robert J.; Vinson, James S.; Hereford, Frank L. (Univ. of Virginia, Charlottesville). Phys. Rev., 153: 255-8(Jan. 5, 1967).

The intensity of the scintillations produced by 5.28-MeV alpha particles in stationary and rotating He(II) has been observed at temperatures between 1.1 and 3.0°K. The results indicate a structure in the intensity-versus-temperature curve which was not apparent in previous less precise measurements. No change in intensity (<0.5%) was observed upon the establishment of rotation-induced vortex lines. (auth)

11569 ATTENUATION OF SECOND SOUND IN HELIUM II BETWEEN ROTATING CYLINDERS. Bendt, Philip J. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 153: 280-4 (Jan. 5, 1967). (LA-DC-8121).

In an annular resonant cavity, it was shown that the attenuation of second sound is the same for solid-body rotation, rotation of the outside cylinder only, and rotation of the inside cylinder only, if plotted against $|\text{curl } v_s|$, where the superfluid velocity v_s is calculated by classical hydrodynamics. Additional attenuation due to secondary flow was observed when the inside cylinder only rotated faster than 0.4 rad/sec. In solid-body rotation, it was found that the attenuation plotted as a function of angular velocity deviates from linearity by not more than 1%, out to 6 rad/sec. The perpendicular mutual-friction coefficient B was measured at 50-mdeg intervals between 1.2 and 2.08°K, with an uncertainty of ±2% in the smoothed values. The velocity of second sound was also measured to ±1%. (auth)

11570 LAMBDA TRANSFORMATION OF LIQUID ^{4}He AT HIGH PRESSURES. Kierstead, Henry A. (Argonne National Lab., Ill.). Phys. Rev., 153: 258-62(Jan. 5, 1967).

Measurements are reported of the pressure coefficient $\beta_V = (\partial P/\partial T)_V$ of ^{4}He(I) and ^{4}He(II) along the isochore which crosses the λ line at $T_\lambda = 1.7683$°K and $P_\lambda = 29.56$ atm, and of the compressibility $\rho\kappa_T = (\partial\rho/\partial P)_T$ along the isotherm $T = 1.7683$°K, the closest points being 2.5 μdeg, 50 μatm, and 10^{-7} g/cm^3 from the lambda line in temperature, pressure, and density, respectively. The data are presented. (M.O.W.)

11571 PREDICTION OF THE TEMPERATURE-DEPENDENT STATIC FORM FACTOR IN He I AND He II. Etters, Richard D. (Douglas Advanced Research Labs., Huntington Beach, Calif.). Phys. Rev., 153: 297-?(Jan. 5, 1967).

A prediction for the temperature-dependent properties of the static form factor in He(I) and He(II) at low momenta is made. The prediction is based upon the notion that a single coherent, collective mode of excitation predominates for temperatures $\theta \leq 2.57$°K and momenta $k \lesssim 0.6$ Å^{-1}. An expression for the dissipative part of the density–density response function $\chi''(k,\omega)$ is obtained, in the collisionless regime. This result exhibits a slight temperature-dependent energy shift in the position of the main resonance, compared with its value at $\theta = 0$°K. However, the "sharp-resonance" structure is retained, reflecting the fact that the collective mode, which is the principal contributor to $\chi''(k,\omega)$ in the regime considered, exists as a nearly independent mode of excitation for all temperatures $\theta \leq 2.57$°K. The expressions for the dynamic and static form factors are derived, with the result that they appear to be insensitive to superfluid behavior. The temperature dependence of the static form factor $S_k(\theta)$ for $0 \leq \theta \leq 2.57$°K is summarized by the inequalities $\Delta S_k/\Delta\theta > 0$ for $k < 0.38$ Å^{-1} and $\Delta S_k/\Delta\theta < 0$ for $k > 0.38$ Å^{-1}. (auth)

11572 LOW-LYING SUPERFLUID STATES IN A ROTATING ANNULUS. Fetter, Alexander L. (Stanford Univ., Calif.). Phys. Rev., 153: 285-96(Jan. 5, 1967).

The low-lying states of rotating liquid He(II) in an annulus ($R_1 < r < R_2$) are studied with the model of a classical inviscid fluid. An exact hydrodynamic solution is obtained with the method of images for a system consisting of rectilinear vortices with circulation κ combined with circulation Γ_1 about the inner cylinder. The energy and angular momentum are calculated, both for an arbitrary configuration of vortices and for the particular configuration of a symmetric ring of l vortices. If Γ_1 is treated as a variational parameter, the critical angular velocity Ω_0 for the appearance of vortices in a narrow annulus is $(\kappa/\pi d^2)\ln(2d/\pi a)$, where d is the width of the annulus and a is the radius of the vortex core. For $\Omega < \Omega_0$, the equilibrium state is an irrotational (vortex-free) flow with quantized circulation nκ (n = 1,2 . . .); these levels are equally spaced, and a given quantum state represents the lowest free energy only in a narrow angular-velocity interval of $\kappa/2\pi R^2$, where R is the mean radius of the annulus. The maximum quantum number of irrotational circulation is $2\pi R^2\Omega_0/\kappa = 2(R/d)^2\ln(2d/\pi a) \gg 1$. For $\Omega > \Omega_0$, the vortices lie on the circumference of a ring midway between the walls, and the number of vortices increases rapidly with Ω. If Γ_1 is constrained to vanish identically, the critical angular velocity Ω_c for the appearance of vortices in a narrow annulus is of order $\kappa/2\pi Rd$; this is equivalent to Feynman's critical velocity $v_c = O(\hbar/md)$ for singly quantized vortices with $\kappa = h/m$. In the opposite limit of a wide annulus ($R_1 \ll R_2$), the equilibrium state is shown to agree with Vinen's earlier calculations. (auth)

11573 FUNCTIONAL AVERAGES IN THE THEORY OF SUPERCONDUCTIVITY. Everts, Hans-Ulrich (Univ., Cologne). Z. Phys., 199: 211-38(1967).

The grand canonical partition function of a superconductor described by Gorkov's model Hamiltonian is represented as a functional integral with Gaussian measure. The integrand can be regarded as the partition function of a free Fermi system which interacts with a fluctuating external source potential. Perturbation-theoretic techniques are applied to the latter partition function. The Gibbs' potential proves to be stationary with respect to the energy gap parameter Δ. From the stationarity condition an equation for Δ is obtained which is a generalization of the usual Bardeen-Cooper-Schrieffer (BCS) equation. For the evaluation of the functional integral a variational procedure is employed. It leads to an expression for the Gibbs' potential which shows a further remarkable stationarity property. As its simplest approximation this expression contains a result that was firstly derived by Thouless in the ladder graph approximation. (auth)

11574 STATIC DIELECTRIC CONSTANT OF A SUPERCONDUCTOR. Seiden, Joseph (Faculte des Sciences, Orsay, France). J. Phys. (Paris), 27: 561-9(Sept.-Oct. 1966). (In French).

The difference $\delta\epsilon = \epsilon^S - \epsilon^N$ between the static dielectric constants of a metal in the superconducting and in the normal states in the limit of weak coupling ($N(0)V \ll 1$) was calculated. In the limit $Q \ll k_F$, it is shown by a macroscopic treatment that $\delta\epsilon/\epsilon^N = \frac{1}{2}(N(0)V)^2(\Delta/\hbar\epsilon_F)^2$. A microscopic treatment for $Q \gg k_F\omega_D/\epsilon_F$ shows that the restoration of gage invariance introduces in the B.C.S expression of $\delta\epsilon$ new terms of the same order of magnitude as those that come from B.C.S. as soon as $Q \simeq k_F$. The influence of the variation $\delta\epsilon$ on phonon spectra, quadrupolar resonance lines, and electron density oscillations around an impurity is considered. (auth)

11575 SUPERCONDUCTING PERMANENT MAGNET FROM Nb_3Sn WITH IRON CORE. Lange, F. (Institut fuer Tieftemperaturphysik, Dresden). Cryogenics, 6: 108-9(Apr. 1966).

Investigations in superconducting Nb–Zr wires required a magnetic field of 50 to 60 kOe, which would not vary with time, and which was concentrated in a very narrow space. The stray

field had to be as low as possible. To meet these demands, a Nb_3Sn hollow cylinder previously described was provided with an additional iron core. (W.D.M.)

11576 CRYOSTAT FOR INTERMEDIATE TEMPERATURES. Laquer, H. L.; Decker, D. L. (Los Alamos Scientific Lab., N. Mex.). Cryogenics, 6: 109-11(Apr. 1966). (LA-DC-7332).

A cryostat with limited convection and requiring no internal vacuum enclosures which was developed for work in the region above the boiling point of helium is described. The apparatus features a heated capsule in limited thermal contact with a liquid helium container, with the contact being provided by conduction and convection in a gas space and by some conduction through metallic linkages. The scheme provides a simple means of converting a liquid helium or hydrogen bath cryostat to work at higher temperatures, while leaving the main experimental region at the bottom of the cryostat. (W.D.M.)

11577 SUPPRESSION OF MAGNETIC FIELD FLUCTUATIONS IN CRYOGENIC EXPERIMENTS. Votruba, J.; Sott, M. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Cryogenics, 6: 299-301(Oct. 1966).

In some kinds of low temperature experiments a very high stability is required of an applied magnetic field. However, it is extremely difficult to stabilize the field of large solenoids fed by motor-generators or rectifiers. A possibility for ripple suppression is to use tubes or ringlets made of a highly conducting material; these compensate the field fluctuations inside by induced eddy currents. A high purity copper shield of 2 mm thickness reduces a ripple field of 100 c/s by a factor of about 20 at liquid helium temperature. A new modification of such a shield is described. It has a much higher efficiency at low frequencies than does a high purity copper shield of the same dimensions. (W.D.M.)

11578 TEMPERATURE DEPENDENCE OF THE CRITICAL FIELD IN SUPERCONDUCTING VANADIUM. van Gurp, G. J. (Philips Research Labs., Eindhoven, Netherlands). Phys. Status Solidi, 19: 173-6(Jan. 1, 1967).

The critical field H_{c2} of superconducting vanadium is determined from critical-current measurements on cold-rolled and annealed foils and on a single crystal. The temperature dependence is found to be stronger than predicted by theory. The critical field is found to be anisotropic in the single crystal. Values of $\kappa_1 = H_{c2}/H_c\sqrt{2}$ are determined which, by extrapolation to zero resistivity, show that pure vanadium is a type-II superconductor with κ_1 comparable to that for pure niobium. (auth)

11579 VARIABLE HEAT SWITCH FOR USE BELOW 1 DEG K. Dash, J. G.; Goodstein, D. L.; McCormick, W. D. (Univ. of Washington, Seattle). Cryogenics, 6: 241(Aug. 1966).

In the course of heat capacity measurements at low temperatures, a superconducting heat switch whose thermal conductivity can be varied over a substantial range was developed. The heat switch consists of a 4-in.-long filament of lead. It is placed in a helical groove cut in a nylon tube of 1-in. length, 0.125-in. diameter, and 0.030-in. wall thickness. The filament is soldered into threaded copper fittings at each end so that it may be linked to the calorimeter and salt pill. Filaments of cross-sectional area 15 to 40×10^{-6} in.^{2} have been used. (W.D.M.)

11580 SIMPLE, VERSATILE, CAPSULE TECHNIQUE FOR LOW-TEMPERATURE EXPERIMENTS OF LONG DURATION. Wigley, D. A. (Oxford Univ.). Cryogenics, 6: 359-61(Dec. 1966).

There is considerable interest in the changes in the physical properties of plutonium and other transuranic metals brought about by self-irradiation damage at low temperature. A technique must allow complete containment of the plutonium specimens so preventing the health hazards associated with this highly radioactive metal. A solution to these requirements has been found in the development of cryogenic capsules, which contain the specimens and which are small enough to allow their storage in standard bulk liquid helium containers. An improved capsule technique is described which permits the detection of leaks in the system and the safe relief of any consequent overpressures. It has been successfully used for self-irradiated in liquid helium for periods exceeding 3,000 hr and for numerous cycles between ambient and liquid helium temperatures. (W.D.M.)

11581 SPIN-REVERSING SCATTERING AND NUCLEAR MAGNETIC RESONANCE IN SUPERCONDUCTING TIN. Wright, Fulton Jr.; Hines, William A.; Knight, W. D. (Univ. of California, Berkeley). Phys. Rev. Lett., 18: 115-16(Jan. 23, 1967).

The residual NMR shift in superconducting tin was measured in samples of average particle dimension between 150 and 600 Å and in samples containing up to 1 at. % Pb or In impurity. The results suggest that the dominant contribution is attributable to the Pauli paramagnetism, which is modified by spin-reversing scattering in the superconductor. In this interpretation, the results are consistent with the BCS theory of superconductivity. (auth)

11582 TYPE II SUPERCONDUCTORS. Goodman, B. B. (Centre de Recherches sur les Tres Basses Temperatures, Grenoble, France). Rep. Progr. Phys., 29: 445-87(1966).

A review is given of recent work which has led to the discovery of type-II superconductors and to an understanding of many of their properties. A brief historical introduction, which summarizes the early ideas concerning the magnetic behavior of superconductors, is followed by a presentation of the Ginzburg–Landau equations. Some of the more general consequences of these equations, including the existence of quantized vortex lines, are examined. Abrikosov's solutions of the Ginzburg–Landau equations in homogeneous extended defect-free, bulk specimens of type-II superconductors are then presented, and the more recent work which generalizes the theory to all temperatures is mentioned. These predictions are then compared with measurements of the bulk thermodynamic properties and with various experiments which confirm the existence of vortex lines. Two special effects, the superconducting surface sheath and the influence of the paramagnetism of the normal state, are then discussed. A section is devoted to irreversible phenomena. Particular attention is paid (i) to vortex line pinning, the static irreversible magnetic behavior and bulk transport currents, and (ii) to the various types of vortex line motion: flux creep, flux flow, vortex line vibrations and flux jumps. (auth)

11583 SUPERCONDUCTING SOLENOID FROM A THREE-COMPONENT ALLOY GENERATING FIELDS OF OVER 75,000 Oe. Andrianov, V. V.; Zenkevich, V. B.; Sokolov, V. I.; Sychev, V. V.; Tovma, V. A.; Fedotov, L. N. (Scientific Research Inst. for High Temperatures, USSR. Central Scientific Research Inst. for Ferrous Metallurgy, USSR). Dokl. Akad. Nauk SSSR, 169: 316-19(July 11, 1966). (In Russian).

A superconducting magnet has been constructed which generates magnetic fields of more than 75,000 Oe using wire made from an alloy of niobium (65%), titanium (15%), and zirconium (about 9%), the remainder being other components selected for their metallurgical properties. The critical temperature of the material is 9.8 to 10°K. Because of its relatively low brittleness, the 0.25-mm o.d. copper-plated wire could be drawn by standard methods into four-kg coils representing a total length of 12 km. After cold working in vacuum or in a helium atmosphere, both types of wire were coated with a polyester varnish to add a 0.03-mm layer to the diameter. The magnet, with a 16-mm inner diameter, consisted of 3 concentric sections wound onto aluminum-alloyed formers. The inner section alone, using 17,762 turns of vacuum cold-worked wire, generated 65,000 Oe; the two other sections made of 15,210 and 10,480 turns of wire cold-worked in a helium atmosphere, and wound on a common former, generated 43,500 Oe. The maximum magnetic-field intensity of the magnet was 76,300 Oe. Even though the solenoid has been repeatedly driven normal, no damage has been observed. (ATD)

11584 RESPONSE OF SUPERCONDUCTORS TO TRANSVERSE AND LONGITUDINAL WAVES. Cullen, James Robert. College Park, Md., Univ. of Maryland, 1966. 102p.

Thesis.

In Part I the attenuation rate of shear waves in a superconductor is calculated assuming the electrons to interact with the lattice shear waves by means of an electromagnetic coupling. The justification of this selection at the expense of "real metal" and impurity effects is discussed. Results are obtained for the low-frequency and high-frequency ranges, as a function of temperature, from 0°K to the critical temperature. The high-frequency results lead to the conclusion that, within a range of wave numbers that varies from superconductor to superconductor, it might be possible to measure the kernel of the integral relating current to field in the electrodynamics of superconductors. These results were based on the use of the frequency- and wave-number-dependent conductivities, appropriate to the superconducting state. The low-frequency results are in accord with those predicted on the basis of simple models of the superconducting state, and also agree with existing experimental data. Part II is devoted to a study of the response of a superconductor to longitudinal waves. In Chapter I, some general rules, applicable to any large system are discussed. In Chapter II, a comparison of the simplified Bardeen–Cooper–Shrieffer model for the possible excitations is made with the rules given in Chapter I. It is found that the simple model fails to satisfy, besides the well-known "f-sum" rule, also the "density-fluctuation" theorem derived from statistical mechanics. With the inclusion of collective modes of long wavelength and low frequency, both these rules are seen to be fulfilled. The effects of these collective modes on the pair correlation function is calculated, as well as the effect of normal state interactions between the quasiparticles. The latter effect is dominant at short wavelengths. The correlation energy is then calculated using the pair correlation

function for a superconductor, including collective effects. The effects of these modes is found to be negligible on the superconducting condensation energy, for the case of bulk superconductors. In the fourth Chapter, the effect of the superconducting transition on the velocity of the longitudinal phonons is studied. The results indicate that the effect is quite small, for all wave numbers. (Dissertation Abstr.)

Plasma and Thermonuclear Physics

Refer also to abstract 12027.

11585 (NP-16441) COMPRESSION DE CHAMPS MAGNETIQUES A L'AIDE D'EXPLOSIFS. (Compression of Magnetic Fields Using Explosives). Aycoberry, C.; Papillon, Y.; Plantevin, J. P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [nd]. 45p. (In French). Dep. mn.

Two theoretical approaches used for the calculation of the compression of magnetic fields with explosives are outlined. Experimental apparatus for the measurement of compression is described, and measurements are reported. The theoretical results are comparable to those reported previously by Fowler. The experimental results show that the compression is almost independent of the initial field, in opposition to theory. The agreement between theory and experiment is, however, satisfactory up to compression ratios of the order of 4. The value of the field has no effect on the movement of the tamper for the first 5 μ sec. (J.S.R.)

Confinement and Heating of Plasma

11586 (CEA-R-3103) LE MOUVEMENT D'UND PARTICULE DANS UN CHAMP DE CHARGE D'ESPACE RADIAL ET UN CHAMP MAGNETIQUE AXIAL. (Motion of a Particle in a Radial Space-Charge Field and in an Axial Magnetic Field). Canobbio, Ernesto; Finzi, Umberto (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct. 1966. 14p. (In French). Dep. mn.

The motion of a charged particle in an axial uniform steady magnetic field, under the action of a radial space charge is calculated. A cylindrical symmetric charge distribution similar to the one which is observed in hf plasma accelerators is assumed. The particle motion is discussed with the method of effective potentials. A radial acceleration of ions is shown to be possible if the space charge density is sufficiently high. The displacement of the turning points of the trajectories due to the electrostatic field is calculated in the low plasma density approximation. Finally a hf circularly polarized electric field is introduced, the shift in cyclotron resonance is calculated and a low-frequency resonance is found to be possible. (auth)

11587 (IPP-1/53) UNTERSUCHUNGEN ZUR DRIFT EINES PLASMARINGS IM TOROIDALEN MAGNETFELD. (Investigations on the Drift of a Plasma Ring in a Toroidal Magnetic Field). Junker, Josef (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Oct. 1966. 55p. (In German). Dep. mn.

A plasma ring confined by a toroidal magnetic field drifts outward in a radial direction. This drift is caused by an acceleration proportional to an average plasma temperature. Measuring this temperature spectroscopically using the H_β line intensity and the intensity of a continuum interval allows one to calculate the acceleration. Integrating this acceleration twice with respect to time yields the motion of the meridional center of mass of the plasma. The drift motion obtained in this way is compared with the motion directly observed by smear photographs. Within the margins of error of the temperature determination both results give the same drift motion. As a consequence of successive compression and decompression of the plasma ring, magnetohydrodynamic theory shows an oscillating motion of the plasma center in the meridional plane in addition to the gross drift motion. This oscillation can be observed and agrees well in phase but not in amplitude with the theoretical results. The investigations described here were conducted on a toroidal Θ-pinch plasma in a tube with a major diameter of 50 cm and a minor diameter of 6 cm. The preionized plasma is compressed and heated by a 4-kJ capacitor bank. The average temperature rises to 7 eV. At a time 2.5 μsec after the onset of the compression, the plasma touches the outer wall of the glass vessel. (auth)

11588 (IPP-2/50) MEASUREMENTS OF THE DIFFUSION RATE OF A WEAKLY IONIZED PLASMA TRANSVERSE TO A MAGNETIC FIELD. Geissler, K. H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Aug. 1966. 21p. Dep. mn.

The decay times of a weakly ionized after glow plasma were measured as a function of the magnetic field and neutral gas pressure. The magnetic field was varied from 214 to 2500 gauss. The neutral pressure was varied from 3×10^{-2} to 8.5×10^{-2} torr. The working gas was helium. The plasma, which had mean densities between 10^8 and 5×10^9 cm^{-3}, was confined by a glass tube 70 cm in length and with an inner diameter of 5.15 cm. It was found that the coefficient of the plasma diffusion perpendicular to the magnetic field may be written as a sum of two contributions, one being of the classical type and the other of the Bohm type. (auth)

11589 (IPP-2/51) INVESTIGATION OF THE DIFFUSIVE DECAY OF A PLASMA CONTAINED IN A CONDUCTING CYLINDER IN THE PRESENCE OF A MAGNETIC FIELD. Geissler, K. H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Sept. 1966. 15p. Dep. mn.

When a magnetic field is present, the diffusion of a plasma inside a conducting cylinder is not ambipolar. Electric currents are thus associated with the diffusion of particles to the walls. To measure these electric currents directly, a cylinder of mutually insulated segments was used. Measurements were made in a decaying helium plasma with neutral pressures between 0.01 and 0.1 torr and applied magnetic fields between 160 and 2600 gauss. The axial and radial current distributions are obtained. The currents are found to decay exponentially with time, the relative spatial distribution remaining constant. Experimental data obtained for higher magnetic fields may be described in good approximation by a coefficient of transverse diffusion equal to 2.2 times the Bohm diffusion coefficient. (auth)

11590 (IPP-2/52) REVIEW OF MUNICH ALKALI PLASMA EXPERIMENTS IN TOROIDAL DEVICES. CESIUM PLASMA IN THE STELLARATOR WENDELSTEIN WIb. Eckhartt, D.; Gierke, G. v.; Grieger, G. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Oct. 1966. 28p. Dep. mn.

Brief summaries are given on the various experiments on the confinement of alkali plasmas in toroidal devices. (M.O.W.)

11591 (ORO-3405-10) INVESTIGATION OF UNIVERSAL PLASMA INSTABILITIES. Quarterly Report No. 5, September 1–November 30, 1966. (Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Contract AT(40-1)-3405. 10p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Construction properties of the thermal plasma device (Q machine) being built at the University of Maryland are discussed. The vacuum chamber, magnets, and the experimental platform are discussed. (M.O.W.)

11592 (UCRL-50002-66-1) CONTROLLED THERMONUCLEAR RESEARCH ANNUAL REPORT, JULY 1965–JUNE 1966. (California Univ., Livermore. Lawrence Radiation Lab.). Contract W-7405-eng-48. 182p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Abstracts were prepared for 6 individual sections. (M.O.W.)

For abstracts of individual sections see: 11593–11596, 11634, and 11670.

11593 (UCRL-50002-66-1, pp 5-59) MAGNETIC MIRROR PROGRAM. (California Univ., Livermore. Lawrence Radiation Lab.).

Results are reported on the following studies associated with the multistage high-compression experiments: line-tied simple mirror operation, radio-frequency data, quadrupole operation, and instrumentation and technical developments. Electron-energy-analyzer measurements made in the Table Top IV experiment are reported. Various Alice plasma experiments are reported as follows: computer investigation of ion orbits in Alice octupole and quadrupole magnetic fields, beam development, cross-section measurements and some related neutralizer considerations, vacuum and surface physics, cold-plasma development, plasma formation in toroidal systems by neutral-atom injection, loss-cone electrostatic instabilities in mirror-confined plasmas, and diffusion of particles in periodic mirror systems. (M.O.W.)

11594 (UCRL-50002-66-1, pp 60-90) ASTRON PROGRAM. (California Univ., Livermore. Lawrence Radiation Lab.).

Brief summaries are given for modification of the Astron Electronic equipment to achieve a burst mode of 100 pulses at 1440 PPS, increase of the beam current, and the proposed five-year program and a description of the new Astron accelerator. Results of experimental studies are given for the following: trapping at different gas pressure and high vacuum, abrupt change of containment time of the E-layer at a critical pressure, rf observations during the trapping phase, behavior of the E layer in high vacuum, E-layer electron gyrofrequency radiation at particular magnetic-field settings, helical-beam observations, plasma density measurements, and comparison of trapping and containment with different wall geometries. (M.O.W.)

11595 (UCRL-50002-66-1, pp 91-109) LIVERMORE TOROIDAL-CONFINEMENT PROGRAM. Birdsall, Dale H.; Briggs, Richard J.; Furth, Harold P.; Hartman, Charles W.; Munger,

Richard H. (California Univ., Livermore. Lawrence Radiation Lab.).

Plasma heating in the Levitron device using microwaves is discussed, along with the following: minimum-B Levitron, superconducting hot-ion minimum-B Levitron proposal, stuffed cusp, and alkali metal plasma experiments. (M.O.W.)

11596 (UCRL-50002-66-1, pp 149-69) ENGINEERING DEVELOPMENT. (California Univ., Livermore. Lawrence Radiation Lab.).

Mechanical engineering developments are reported on the 2X multistage compression facility, Alice low-energy neutral-beam experiment, Alice source foil coil, cryogenic project, construction of compound coil winder, Astron, and design of Astron main field coils. Electronic engineering is reported on the Pyrotron program, Astron program, toroidal-confinement program, basic experimental plasma physics program, cryogenic project, and advanced technology. (M.O.W.)

11597 (SC-T-66-0771) ROLE OF THE INERTIAL FORCE IN THE LINEAR z-PINCH. Hertz, W.; Koller, A.; Michel, A. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Z. Naturforsch., 19a: 1089-98(1964). 26p. Dep. mn. JCL $2.60 fs, $0.98 mf.

In a fast linear z pinch (f = 600 kc, W = 800 joules) the Lorentz force is essentially effective on the plasma near the chamber wall. Only during the later phase of the implosion it prevents the formation of the rarefaction wave, which propagates radially outward from the outer surface of the pressure wave following the shock front. The vanishing of the Lorentz force does not influence further propagation of the cylindrical shock wave if the discharge is crowbarred in the first current-zero before the shock front hits the axis or if the current is damped to a small amount compared with its initial value. No Kruskal-Schwarzschild instabilities have been observed. Under these conditions the z pinch may be followed by a θ pinch before the plasma of the first reaches the chamber walls. There is no screw-shaped superposition of the magnetic fields in this case. Theoretical calculations of the plasma flow are in good qualitative agreement with the experiments. For a 60-kJ discharge plasma pressure and temperature are calculated at the time of maximum contraction by numerical integration of the equation of motion. (auth)

11598 KINETIC EQUATION FOR A HOMOGENEOUS NONGYROTROPIC MAGNETOPLASMA. Haggerty, M. J. (Univ. of Maryland, College Park). Can. J. Phys., 45: 220-5(Jan. 1967).

In the development of a kinetic theory of transverse diffusion, results were derived that, in the homogeneous case, can be compared with those of Sundaresan. Some further results for the homogeneous nongyrotropic plasma are presented, including a kinetic equation that properly includes collective effects. Some minor errors in Sundaresan's analysis are pointed out. It is shown that when collective effects are ignored, this theory yields the corrected version of Sundaresan's equation. When collective effects are included, the two theories yield kinetic equations that seem to disagree with each other. (M.H.R.)

11599 IMPLOSION OF A METAL LINER BY THE ACTION OF A MAGNETIC FIELD. Alikhanov, S. G.; Budker, G. I.; Kichigin, G. N.; Komin, A. V. Zh. Prikl. Mekh. Tekh. Fiz., No. 4, 38-41(July-Aug. 1966). (In Russian).

The experimental results of theta-pinch of metal liners by the action of a magnetic field of a single-turn solenoid are presented and compared with theoretical data on the collapse mechanics of liners. The charge of a 5×10^{-2} F condenser at a voltage of 4 kV was used to activate the solenoid. AD-1M (aluminum) and M-1 (copper) cylindrical liners 80 mm in outside diameter and 150 mm long were used. Wall thickness was 2.5 mm with the aluminum liner and 1 mm with the copper liner; weight was 250 g and 350 g, respectively. The circuit current and battery voltage were recorded along with other data during the experiment. A series of photographs taken from the end projection of the liner during the process of collapse showed that the liner's cross-section area remains constant and that its cylindricality is unimpaired. An analysis of the interrelationship existing between the stage of collapse, the speed of collapse, and the circuit current showed that most of the acceleration occurs during the first half of travel, viscosity of the material and the central air pad causing a decrease in acceleration during the second half prior to the explosion. The ensuing vapor cloud, having a reduced inductance because of its expansion, is said to explain the continuation of the current peak of 2.8×10^6 Ma in the circuit after the collapse. The copper liner displayed the same characteristics of the process as the aluminum liner. The kinetic energy of the liner acquired in acceleration reached 100 kJ at 35 percent efficiency. This energy level is considered to be of practical interest for such applications as plasma heating and the production of megagauss magnetic fields. (ATD)

11600 METASTABLE MEASUREMENTS IN FLOWING HELIUM AFTERGLOW. Huggins, R. W.; Cahn, J. H. (Univ. of Illinois, Urbana). J. Appl. Phys., 38: 180-8(Jan. 1967).

Microwave and optical techniques have been used to measure the decay of the neutral metastable and the charged species in a flowing helium afterglow. Impurity gases, oxygen and argon, are introduced into the afterglow, and measurements of the resulting ionization and excitation yield values for the triplet metastable diffusion coefficient and three-body combination coefficient of 490 $cm^2\ sec^{-1}$ torr and 0.25 $sec^{-1}\ torr^{-2}$, respectively. In addition, the ambipolar diffusion coefficient of the molecular helium ion was found to be 724 $cm^2\ sec^{-1}$ torr. The mean helium pressure was in the range of 5 to 35 torr and the gas nominally at room temperature. Absolute triplet metastable densities early in the afterglow were also measured. (auth)

Diagnostics of Plasma

Refer also to abstracts 10696 and 10700.

11601 (AFCRL-66-5) THE EFFECT OF CHEMICAL ADDITIVES ON THE ELECTRON DENSITY OF PLASMA JETS. Final Report, December 1, 1962-November 30, 1965. Atallah, Sami; Sanborn, Wayne A.; Hoodbhoy, Alamin (Tufts Univ., Medford, Mass. Dept. of Chemical Engineering). Dec. 1965. Contract AF 19(628)-2377. 66p.

Three chemical means for reducing the electron density in a plasma sheath were investigated. These methods were: the addition of electrophilic atoms or radicals, the addition of micron size refractory dust particles, and the addition of substances that will undergo an endothermic reaction in the plasma. Several hydrocarbons, sulfur hexafluoride, water vapor, and submicron silicon oxide, aluminum oxide, aluminum and carbon particles were injected into air and nitrogen plasmas at pressures varying between 30 and 2.5 inches Hg. The change in x-band microwave transmission across the plasma was noted. Among all the compounds used, sulfur hexafluoride was found to be the most effective in improving transmission and this was attributed to the presence of highly electrophilic fluorine atoms. It was at least fifteen times as effective as water, on a mole basis, and therefore about twice as effective on a weight basis. (auth)

11602 (AFCRL-66-765) THEORETICAL AND EXPERIMENTAL STUDY OF A SURFACE WAVE ON A TEMPERATURE COLLISIONAL PLASMA COLUMN. Scientific Report No. 14. Kolettis, Nicholas J. (Case Inst. of Tech., Cleveland, Ohio). Nov. 1966. Contract AF19(628)-1699. 140p.

The axisymmetric TM (transverse magnetic) surface wave mode, excited by a magnetic current source and propagated on a uniform temperate plasma column with collisions, is analyzed. Numerical solutions of the determinantal equation for the sourceless problem are presented in the form of "βa vs. f" and "αa vs. f" dispersion curves, with "β" and "α" the propagation and attenuation factors of the mode, respectively, "a" the column radius and "f" the applied frequency. A most prominent characteristic of these solutions is the strong dependence of α upon "ν", the effective collision frequency for momentum transfer between electrons and neutrals. Temperature effects play a secondary overall role. The theory has been implemented by an experiment performed on a low-pressure (4 to 600 μ Hg) dc Argon discharge (20 to 400 mA) in a thin-walled glass tube, coupled with a Fabry-Perot type resonator of adjustable length. Experimental β's and α's for the mode were first determined from recorded standing wave patterns inside the resonator, over the frequency range of 40 to 1100 Mc. The data were then used in conjunction with the theory as a diagnostic tool, to estimate an average electron density and an effective collision frequency in the discharge, at a given pressure and current. (auth)

11603 (ARL-65-92) SPECTROSCOPIC STUDIES OF ARGON AND NITROGEN PLASMAS AT REDUCED PRESSURE. TEMPERATURE DISTRIBUTIONS IN PLASMAJETS AND WALL-STABILIZED ARCS. Klein, Lothar; Babrov, Harold J. (Warner and Swasey Co., Flushing, N. Y.). Mar. 1965. Contract AF33(615)-1178. 42p. CFSTI.

Stationary plasmas at reduced pressure (0.02 to 0.1 atm) were studied by two different experimental approaches, the plasmajet and the wall-stabilized arc. The nitrogen plasmajet at low pressure is characterized by the appearance of a shock front (Mach disc) and exhibits pressure and temperature gradients. A method based on the atomic Boltzmann plot in absolute intensity units was used to obtain both the pressure and the temperature distribution. A wall-stabilized arc device with wide confining channel proved to be well suited for obtaining a high current (250 A), low pressure (0.1 atm) argon arc. Core temperatures above 16,000°K were determined and a high degree of ionization observed. The absence

of pressure gradients makes the modified wall-stabilized arc a useful tool for research at reduced pressure, but problems of arc stability and symmetry remain to be solved. The wavelengths of several new lines in the argon and nitrogen spectrum were determined, and a strong triplet in the near ultraviolet could be classified as belonging to the transition $3s\ ^2P-5p\ ^2D^0$ of N I. (auth)

11604 (IPP-1/52) STOSSWELLENEXPERIMENTE AM ANTI-PINCH. (Shock Wave Experiments on the Inverse Pinch). Engelhardt, Wolfgang (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Sept. 1966. 42p. (In German). Dep. mn.

An inverse z-pinch device was used in order to produce shock waves in either a preionized or a neutral deuterium gas. The properties of the magnetic piston were examined measuring the current density, the electron density and the velocity of the expanding plasma cylinder. It could be shown that the current and hence the magnetic field is penetrating into the plasma with about the same velocity as the shock wave would separate itself from the accelerating magnetic field boundary. Without preionization the magnetic piston is sweeping up 70 to 100% of the total mass whereas this value reduces to about 40 to 70% in a preionized plasma. An inhomogenous density distribution caused by the preheating discharge as well as a more penetrable piston in case of the preionized discharge seems to be responsible for this effect. The dependence of the piston velocity on time and initial density agrees quite well with calculations using the snow plow model. From space and time resolved density measurements the piston velocity and the shock front velocity could be evaluated and compared with the predicted values as given by modified Hugoniot conservation equations. (auth)

11605 (MIT-1842-36) PLASMA DIAGNOSTICS. Ingraham, J. Charles; Brown, Sanborn C. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics). May 27, 1966. Contracts AT(30-1)-1842; DA36-039-AMC-03200(E). 46p. (RLE-TR-454). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A practical description is presented of laboratory microwave techniques for studying plasmas, as well as other techniques that can be used in plasma studies. (auth)

11606 (N-66-38710) MEASUREMENTS OF PLASMA ENERGY DENSITY AND CONDUCTIVITY FROM 3 TO 120 KILOBARS. Robinson, James W. (Michigan Univ., Ann Arbor. Dept. of Electrical Engineering). 1966. 39p. (NASA-CR-78481). CFSTI $3.00 cy, $0.65 mn.

Plasma energy density, conductivity, and temperature were measured at various pressures ranging from 3 to 120 kilobars. The experimental work was conducted in two parts: plasmas with pressures to 15 kilobars were formed by capacitor discharges in water, and plasmas with higher pressures were formed by detonating 10 grams of PETN in the water adjacent to the electrical discharge path. At 9.4 kilobars and 35,000°K, the energy density was 15 J/mm^3. An equation of state based upon the Debye shielding theory, without accounting for the distortion of electron quantum states, predicts an energy density of only 3.3 J/mm^3. An approximate calculation is presented which accounts for these distortions, and furnishes an estimate of particle densities from measured energy densities. A peak energy density of 75 J/mm^3 was obtained at 117 kilobars and 10^{29} atoms/m^3. At 10 kilobars and 35,000°K, the conductivity was 3×10^5 $(ohm\ m)^{-1}$ and increased with pressure. At 110 kilobars and 10,000°K, the conductivity was 2.5×10^5 $(ohm\ m)^{-1}$ and also was an increasing function of pressure. (auth)

11607 (NP-16434) DER BEITRAG DER AN DER ANODE VON ANOMALEN, LAENGSBEHINDERTEN H_2-GLIMMENTLADUNGEN REFLEKTIERTEN ELEKTRONEN ZUR IONISATION IM FALLRAUM. (Report on Electrons Reflected to the Anodes of Anomalous Longitudinally Hindered H_2 Glow Discharges for Investigation in Yield Chambers). Wellenhofer, Herbert (Munich Univ. (West Germany)). June 1966. 44p. (In German). Dep. mn.

Thesis.

From the electron energy distributions measured on the anode of strongly longitudinally delayed anomalous H_2 glow discharges, the multiplication M of the electron current density in the drop space was calculated. With these M values the stationarity condition was fulfilled. For the same discharge data, discharge voltage U, and dark space length PD, the energy distribution of the electrons at the glow border was calculated with consideration of the energy dependence of the ionization cross section of electrons in H_2 and of the energy loss of electrons in the ionization. The calculated distributions show the same characteristic pattern of the formation of beam electrons as the measured distributions. The variation between measured and calculated distribution functions is attributed to the effect of electrons which were reflected on the anode. These electrons have a supplementary ionization in the drop space as a result. This supplementary ionization is proportional to the reflection coefficient of the anode material. For the Al anode the increase of the drop space ionization is 30% and for the Ni anode it is 60%. The method used for the measurement of the energy distribution of electrons at the anode yields data on the mechanism in the drop space of a strongly longitudinally delayed glow discharge. (tr-auth)

11608 (NP-16443) TEORIA DEL DIAGNOSTICO ESPECTROSCOPICO DE PLASMAS. (Theory of Spectroscopic Plasma Diagnostics). Jimenez Dominguez, Homero (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ciencias). 1965. 144p. (In Spanish). Dep. mn.

Thesis.

The theory of spectroscopic plasma diagnostics is studied. Some characteristics of ionized gases and phenomena occurring under thermal equilibrium conditions are described. The black body radiation emitted by optically thick plasmas is considered. A formula for the determination of the temperature which characterizes the plasma is derived using as measured data the radiation in the optically thick parts of the spectra. Phenomena occurring within an ionized gas are then considered and expressions explaining quantitatively these phenomena are presented. The broadening of the spectral lines, both natural broadening and Doppler broadening, are considered up to the broadening caused by pressure. This last mode is visualized from two apparently independent viewpoints: the collisional and the statistical. A simple manner for deriving the two viewpoints, using a common point of origin, is presented. A resume is given of the expressions utilized to determine the plasma parameters spectroscopically and the manner in which these are applied. (J.S.R.)

11609 (NP-16471) PROGRESS REPORT FOR MARCH-AUGUST 1966. (Illinois Univ., Urbana. Coordinated Science Lab.). Oct. 31, 1966. Contract DA-28-043-AMC-00073(E). 244p.

It was demonstrated that the vibrational states of gases adsorbed on metal surfaces can be detected by low-energy electron scattering. The results or the initial measurements of this type are reported and discussed. Additional progress in the design and construction of the apparatus for the measurement of the angular and energy distributions of secondary electrons is discussed. Further details are given of improvements to the Schuemann suppressor ion gage which are intended to make it more useful at pressures of 10^{-12} torr and lower region. Experiments under way designed to reach pressures low enough to test the limitations of this gage are also discussed. The status of the cryopumped uhv system to be used for size-effect experiments is discussed. Preliminary results for tunneling experiments intended to show quantum size effects in thin samples are given. Sample-purification techniques for niobium single crystals to be used for tunneling experiments have now produced resistivity ratios as high as 700. Incoherent scattering of microwaves has been used as a diagnostic method to determine the k spectrum of beam-stimulated plasma oscillations. Time-resolved measurements of radiated microwave power are in progress. The Pines-Schrieffer equation has been derived from a hierarchy of equations based on the Bohm-Pines Hamiltonian. The effect of gas conditioning is suppressing field-emission current by as much as 20 orders of magnitude (at a given voltage) and thereby improving the voltage-holding capabilities of the electrodes in ultrahigh vacuum is explained as due to the blunting of the tips of the cathode protrusions by selective sputtering. Quantitative estimates of the time required to produce noticeable blunting effects agree with experimental observations. At 3×10^{-10} torr the measured "half life" of the suppression effect is from one to two weeks for clean tungsten electrodes. (M.O.W.)

11610 (ORO-3393-2) APPLICATIONS OF LIGHT SCATTERING TO PLASMA DIAGNOSTICS. Progress Report. Griem, Hans R. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Dec. 1966. Contract AT(40-1)-3393. 8p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A low energy but large diameter theta pinch is described. The resulting plasma has been used to compare Thomson scattering measurements of electron temperatures with spectroscopic estimates based on time histories of impurity line intensities. Further measurements were concerned with initial plasma conditions for the compression phase, and some consideration was given to light-scattering measurements when the number of particles in the Debye sphere is small. (auth)

11611 (RT-ING-(66)-6) COMPONENTI A MICROONDE FUNZIONANTI AD ALTA TEMPERATURA PER MISURE NELLA FISICA DEI PLASMI. (Use of Microwave Components at High Temperatures for Measurements in Plasma Physics). Garosi, F.; Neri, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 20p. (In Italian). Dep. mn.

The characteristics of microwave components are given that have been used in a range of very high temperatures (1,500 to 2,500°K) to study the properties of uniform alkali plasmas produced in incandescent containers. The results obtained by using such components in experimental investigations on the interaction of alkali plasmas with electromagnetic radiation (8 to 10 GHz) are also reported. (auth)

11612 NONLINEAR THEORY FOR THE PASSAGE OF PULSES OF ELECTROMAGNETIC WAVES THROUGH A PLASMA BOUNDARY. Tsytovich, V. N.; Shapiro, V. D. Zh. Prikl. Mekh. Tekh. Fiz., No. 4, 48-55(July-Aug. 1966). (In Russian).

The role of boundary effects is investigated for the passage of pulses of electromagnetic waves through a plasma boundary. Cases of narrow and wide spectra are analyzed. Stochastic phases of transverse waves and generated longitudinal waves are assumed. The boundary effects may be used to generate longitudinal waves needed for the effective acceleration of particles in the plasma as well as for the modulation and changing of the spectrum of initial transverse waves. The application of boundary effects in diagnostics of turbulent plasma is pointed out. (ATD)

11613 INFLUENCE OF A METAL VACUUM CHAMBER ON THE MEASUREMENTS OF PLASMA PARAMETERS USING A DIAMAGNETIC PROBE. Brzhechko, L. V.; Pavlichenko, O. S.; Shvets, O. M. J. Nucl. Energy: Pt. C, 8: 799-800(Nov.-Dec. 1966).

To find the effect of a metallic chamber on measurements of the diamagnetism of a plasma, the distribution of magnetic potential was found in the plasma column of radius a and of length L in the metallic chamber of radius b. The ends of the chamber were assumed to be conducting. The theoretical analysis is briefly described. (M.O.W.)

11614 RELATIVE INTENSITY OF HELIUM SPECTRAL LINES AS A FUNCTION OF ELECTRON TEMPERATURE AND DENSITY. Mewe, R. (FOM-Instituut voor Plasma-Fysica, Jutphaas, Netherlands). Brit. J. Appl. Phys., 18: 107-18(1967).

The variation with electron temperature (2 to 11 eV) and density (10^{10} to 10^{19} cm^{-3}) of the intensity ratios of spectral lines from helium in subsequent ionization stages is calculated for a steady helium plasma which is optically thin towards these lines. Results are given for the ratio of the intensity of the triplet line of He I at 5876 Å to the intensity of the He II line at 4686 Å. The plasma is assumed to be uniform and fully contained. Known data are used from existing calculations of the ionization degree in hydrogen and of the excited state densities of helium atoms and hydrogenic ions. The effect on the density ratio He III/He II of self-absorption of He II Lyman α radiation is investigated using a simplified model for the processes He II $\rightleftharpoons$ He III. The calculations may not be valid for particle densities less than about 10^{15} d^{-1} cm^{-3}, where d is the size of the plasma in centimeters, or when the plasma is inhomogeneous or transient. (auth)

11615 ION AND ELECTRON ENERGY DISTRIBUTION IN THE HYDROGEN DISCHARGE. Boyd, R. L. F.; Boylett, F. D. A. (London Univ.). Proc. Roy. Soc. (London), Ser. A, 296: 233-42(Jan. 7, 1967).

A small probe which extracts a sample pencil from the distribution of ions and electrons in a low-pressure arc has been used to carry out a retardation energy distribution analysis on these particles. Axial and radial variations in these distributions in a striated hydrogen discharge have been studied. The results confirm the findings of Boyd & Twiddy for electrons and supplement their data with new information on the energy distributions of the positive ions. The measurements at the striation tail-head transition are in accord with Langmuir's double sheath criterion. (auth)

11616 INVESTIGATION OF A HYDROGEN PLASMA WITH HOT ELECTRONS. Tarumov, E. Z.; Bakshaev, Yu. L.; Borzenko, V. L.; Penkuna, V. S.; Rozanova, V. I. Zh. Eksp. Teor. Fiz., 52: 49-65(Jan. 1967). (In Russian).

Results of an experimental investigation of the characteristics of a discharge plasma with "hot" electrons ($n \sim 10^{11}$ cm^{-3}, $T \sim 100$ keV, $n_e T_{e\perp} \sim 6 \times 10^{15}$ eV·cm^{-3}) are presented. The discharge was excited in hydrogen at a pressure $\lesssim 10^{-4}$ mm Hg by a 5 to 6-keV electron beam and a 2 to 3-A current injected along a magnetic mirror ($H/H_0 \approx 4$, $H_0 = 1200$ Oe) under stationary or pulsed conditions. The characteristics of a decay plasma are investigated in the pulsed regime. Simultaneous application of several different methods (x rays, ultra high frequency, light, diamagnetic probe) made it possible to obtain more reliable results. The density of the "hot" electrons in the discharge is $1/10$ and in the decay part $1/3$ of the total plasma density. The presence of three groups of electrons in the discharge plasma is demonstrated, a "hot" group ($T \sim 100$ keV), a "warm" group ($T \sim 100$ eV) and a "cold" group ($T \sim 4$ eV). Two groups, a "hot" and "cold" one, can be discerned in the decay plasma. (auth)

11617 MEASUREMENTS OF PLASMA ENERGY DENSITY AND CONDUCTIVITY FROM 3 TO 120 kbar. Robinson, James W. (Univ. of Michigan, Ann Arbor). J. Appl. Phys., 38: 210-16(Jan. 1967).

Plasma energy density, conductivity, and temperature were measured at various pressures ranging from 3 to 120 kbar. The experimental work was conducted in two parts; plasmas with pressures to 15 kbar were formed by capacitor discharges in water, and plasmas with higher pressures were formed by detonating 10 g of PETN in the water adjacent to the electrical discharge path. At 9.4 kbar and 35,000°K, the energy density was 15 J/mm^3. An equation of state based upon the Debye shielding theory, without accounting for the distortion of electron quantum states, predicts an energy density of only 3.3 J/mm^3. An approximate calculation is presented which accounts for these distortions, and furnishes an estimate of particle densities from measured energy densities. A peak energy density of 75 J/mm^3 was obtained at 117 kbar and 10^{29} atoms/m^3. At 10 kbar and 35,000°K, the conductivity was 3×10^5 $(\Omega\ m)^{-1}$ and increased with pressure. At 110 kbar and 10,000°K, the conductivity was 2.5×10^5 $(\Omega\ m)^{-1}$ and also was an increasing function of pressure. (auth)

11618 THERMAL CONDUCTIVITY FROM POWER AND CENTER TEMPERATURE OF AN ARC. Ter Horst, D. Th. J.; Pflanz, H. M. (Technische Hogeschool, Eindhoven, Netherlands). Z. Phys., 198: 508-26(1967).

By means of the energy balance equation for a cylindrically symmetric arc an expression is derived which shows the thermal conductivity of an arc plasma to be equal to the product of the so-called form factor and the derivative of electric power input with respect to the center temperature. The form factor is a measure of the radial distribution of the electric conductivity and can vary theoretically between $0.5 < 2\pi F_{el} < \infty$. Practical reasoning confirmed by experimental evidence limits the upper value to 1.5. In the case of an arc in nitrogen the form factor was found to vary between 0.77 and 1.23 over a range of arc current from 10 to 200 amps, the peak value occurring at 30 amps. Variation of the form factor with core formation is explained with a two channel arc model. In an appendix to this paper J. Boersma shows that it yields maximum form factors, while the single channel model is to be associated with the minimum form factor $2\pi F_{el} = 1/2$. The new method permits to judge the influence of the radiation losses on the determination of thermal conductivity as well as an estimate of the error of the results. The method is illustrated for the case of nitrogen. (auth)

Kinetics of Plasma

Refer also to abstract 11549.

11619 (AD-802270) CONSOLIDATED SEMIANNUAL PROGRESS REPORT NO. 4, APRIL 1, 1966-SEPTEMBER 30, 1966. (University of Southern California, Los Angeles. Electronic Sciences Lab.). 206p. CFSTI $3.00 cy, $0.65 mn.

Various research work dealing with solid-state physics, applied electromagnetics and plasmas, information sciences, information processing and signal design theory, coding theory and automata studies, hybrid and digital computation, and biological engineering, is reported. A theory is described for the coupling of transverse and longitudinal waves in a plasma below the second electron cyclotron harmonic. (M.O.W.)

11620 (INR-760/VII/PH) MAGNETOHYDRODYNAMIC WAVES IN A HELICAL FIELD. Infeld, Eryk (Institute of Nuclear Research, Warsaw (Poland)). Nov. 1966. 14p. Dep.

The effect of a rectilinear current on Alfven waves in a bounded medium is investigated. It transpires that an infinite spectrum of frequencies corresponds to each Alfven frequency obtained without the current. A radial component of the disturbed field will always be present, even though none need be present for the current-free case. This component is a discontinuous function of the current (discontinuous at zero). An experiment aimed at proving that line current in a cylindrical tube containing liquid sodium splits up the eigenfrequencies, is suggested. (auth)

11621 (IPP-3/45) EXPERIMENTE ZUR UNTERSUCHUNG VON WECHSELWIRKUNGEN ZWISCHEN STOSSWELLEN UND STATIONAEREN MAGNETFELDERN. (Experiments Studying the Interaction of Shock Waves With Stationary Magnetic Fields). Klingenberg, H.; Muntenbruch, H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Nov. 1966. 32p. (In German). Dep. mn.

Interactions occurring between plane shock waves and a magnetic field perpendicular to them under the influence of energy and momentum input and output have been investigated in a theoretical paper by Rebhan. The interaction between flow and field produces

reflected shock or rarefaction waves and varies the intensity of the primary shock. The object of experiments now in progress is to check this theory. The simple conditions necessary are provided by a diaphragm shock tube and a stationary magnetic field, and also by electrodes placed flat against the inside walls of the tube and connected outside the tube. In the preliminary experiments the currents produced on interaction in shock-heated argon plasma are measured as a function of time for varying initial pressure (and hence flow velocity and conductivity), electrode surface area, magnetic field, and load resistance. The maximum short-circuit current is several kA for magnetic fields of a few kG. The time resolution makes it possible (allowing for the inductance of the discharge circuit) to compare the current with the conductivity of the plasma (which depends on relaxation) as a function of time. The values of the conductivity theoretically calculated for the unperturbed shock-heated plasma can be used to estimate the diameter of the discharge channel (arc discharges being involved). This diameter is much smaller than the inner diameter of the shock tube. The interaction with the flow is thus negligibly small. (auth)

11622 (IPPJ–52) SHEET PLASMA MODEL FOR GENERAL PLANE DISTURBANCES. Hasegawa, Akira (Nagoya Univ. (Japan). Inst. of Plasma Physics). Nov. 1966. 25p. Dep. mn.

Sheet plasma model which can be used for studying general plane disturbances in a magnetized plasma is introduced together with some reviews of previous sheet change models. The model may be useful for studying nonlinear effects of general velocity space instabilities propagating with arbitrary angle with respect to a uniform magnetic field. (auth)

11623 (N–66–19146) STATISTICAL MECHANICAL DESCRIPTION OF SCATTERING PROCESSES IN COLLISIONLESS PLASMAS. Macrakis, Michael S. (National Aeronautics and Space Administration, Cambridge, Mass. Electronics Research Center). [1966]. 25p. (NASA-TM–X-57266). CFSTI $3.00 cy, $0.65 mn.

By separating the microscopic equations of motion for the particle density and the fields in a plasma into ensemble average and fluctuating parts one is able to obtain an unambiguous description of scattering of an electromagnetic wave from density fluctuations. The method described can be generalized to include all linear scattering processes in a plasma involving the interaction of transverse and longitudinal waves with fluctuations. (auth)

11624 (N–66–19653) RADIOFREQUENCY AND MICROWAVE SPECTROSCOPY OF MAGNETIZED PLASMAS. Final Report. Crownfield, Frederic R. Jr. (College of William and Mary, Williamsburg, Va. Plasma Physics Lab.). Jan. 1, 1966. 11p. (NASA-CR–71189). CFSTI $3.00 cy, $0.65 mn.

Lists are given of technical reports, meeting papers, and mathematical reports which were presented during a program involving radio frequency and microwave spectroscopy of magnetized plasmas. Also given are major conclusions of the study in which very high frequency oscillation interactions with the Penning ionization gauge are emphasized. (STAR)

11625 (N–66–24584) EXPERIMENTAL STUDY OF THE RELATIONSHIP BETWEEN MOVING STRIATIONS AND PLASMA–ACOUSTIC WAVES. Meskan, D. A. (Case Inst. of Tech., Cleveland, Ohio). [1965] 105p. (NASA-CR-74607). CFSTI $3.00 cy, $0.65 mn.

The velocity, attenuation, and frequency of moving striations in the positive column of a hot cathode glow discharge are determined experimentally. Plasma–acoustic wave dispersion relations which would be appropriate for explaining these striations by means of a linear fluid model are derived. The properties of various large amplitude waves predicted by nonlinear fluid models are discussed. A comparison of the striations' behavior and the plasma–acoustic wave theories demonstrates that the frequently assumed relationship between these two phenomena does not exist. The experiments were performed in an argon discharge at pressures from 20 to 480 mtorr and with discharge current densities on the order of 25 mA/cm^2. Typical electron densities and temperatures were 2×10^{10} cm^{-3} and 2×10^4°K. The velocity of the striations varied from 2.1×10^5 to 1.3×10^4 cm/sec., while the frequency varied from 6×10^2 to 2.3×10^4 cycles per second. (auth)

11626 (NASA-CR–676) STUDY OF INSTABILITIES IN LINEAR HALL CURRENT ACCELERATORS. Garrison, G. W. Jr.; Hassan, H. A.; Seals, R. K. Jr. (North Carolina State Univ., Raleigh). Jan. 1967. 52p. CFSTI $3.00 cy, $0.65 mn.

The stability of a linear Hall current accelerator with applied axial electric and radial magnetic fields against a screw type perturbation is investigated. The analysis is based on the ion and electron conservation equations and takes into consideration the effects of ionization. It is shown that the observed instability cannot be explained when the axial magnetic field is identically zero even when the unperturbed potential and density distributions have both radial and axial dependence. On the other hand, when the axial component of the magnetic field is small, but not zero, the column is unstable, in the absence of an axial density gradient, to a right-handed helical perturbation (m = –1). The resulting instability, which is of the Kadomtsev–Nedospasov type, is analyzed using a normal mode analysis. (auth)

11627 (NASA-CR–677) ON THE RADIATION OF A MAGNETIC LINE SOURCE EXCITED CYLINDER THROUGH AN AXIALLY SLOTTED PLASMA SHEATH. Olte, Andrejs (Michigan Univ., Ann Arbor). Jan. 1967. 58p. CFSTI $3.00 cy, $0.65 mn.

A plasma sheath encloses a perfectly conducting cylinder with a time harmonic magnetic line source on its surface. The plasma sheath has an infinite axial slot. A singular integral equation is formulated for the electric plasma current whose solution unfortunately was not found. However, some approximations for the current of underdense plasma are suggested to predict the effect of the slotted plasma sheath on the cylinder radiation. For overdense plasma the slot may support traveling waves which transport power from the source to the external space. Radiation is calculated through a narrow parallel face slot that supports the propagation only of the lowest order mode. It is shown that the radiation in the forward direction is comparable to the case of no plasma sheath. (auth)

11628 (NASA-TN–D-3782) THREE-DIMENSIONAL PLASMA ACCELERATION THROUGH AXISYMMETRIC DIVERGING MAGNETIC FIELDS BASED ON DIPOLE MOMENT APPROXIMATION. Kosmahl, H. G. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Jan. 1967. 28p. CFSTI $3.00 cy, $0.65 mn.

The acceleration of a tenuous plasma whose initial energy is stored in the magnetic dipole moments of the electrons immersed in a diverging magnetic field was investigated theoretically. Adiabatic conservation of the dipole moments and axisymmetric steady-state fields were assumed, and three-dimensional trajectories of the plasma and the induced space-charge fields were computed. The computations were carried out for atomic weights of 40 and 130. The particle trajectories cross the field lines, and the plasma emerges as a well-defined beam. From the amount of divergence in the beam, a propulsive efficiency is defined. This efficiency is primarily a function of the radius and the length of the solenoid and the position beyond the center of the magnetic field at which the plasma of a given radial extension is initially injected. Conditions for a favorable design of a propulsion device are shown, and the mechanism of the acceleration process is explained. Results agree well with experiments performed on a microwave-powered plasma accelerator working under conditions that approximate the theoretical assumptions. A significant conclusion of these studies is that trajectories are independent of the ionic mass and the magnitude of the dipole moment, that is, of the energy of the particles. (auth)

11629 (NP–16466) REFLECTION OF ELECTROMAGNETIC WAVES BY A COLD MAGNETOPLASMA. Rijnhuizen Report 66-35. Sluijter, F. W. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). Oct. 1966. 120p. Dep. mn.

The propagation of monochromatic, linearly polarized, plane electromagnetic waves in a cold electron plasma is studied theoretically. The direction of propagation is taken perpendicular to a static magnetic field. The plasma density is assumed to be proportional to $1 + \tanh \zeta$ (where ζ is proportional to one of the Cartesian coordinates). Wave equations for both the ordinary and extraordinary wave modes are derived by linearization. Starting from a non-zero temperature conditions are evaluated under which its effect may be neglected. For that purpose the equations are supplemented with an adiabatic equation of state. Subsequently, both wave equations are solved exactly, thus leading to full wave solutions. The equation for the ordinary wave mode reduces to the hypergeometric equation in accordance with the classical Epstein theory. Reflection and transmission coefficients are given for both directions of propagation of the incident wave. The wave equation for the extraordinary wave mode reduces for normal incidence to Heun's equation. This case includes the possibility of a local resonance somewhere in the density profile, i.e., the case of Budden tunneling. Again exact reflection and transmission coefficients are given for both directions of propagation of the incident wave. These coefficients are expressed in terms of Heun's functions. Some features of the theory of Heun's equation are presented in an appendix. Wave propagation in a homogeneous plasma is next considered. Starting from the nonlinear cold plasma equations expressions are derived for the lowest order corrections to the well-known solution of the linearized equations. The nonlinear terms are treated as perturbations. The appearance of secular behavior is discussed. The corrections are presented in the form of forced waves. Expressions are evaluated for forced waves due to the interaction of two ordinary waves, to the interaction of an ordinary

and an extraordinary wave, and for the forced wave due to an extraordinary wave alone. These expressions then serve to solve a boundary value problem up to the considered order taking into account the longitudinal components of extraordinary waves involved. (auth)

11630 (PPL-AF-9) APPROXIMATE CALCULATION OF THE KOLMOGOROV–OBUKHOV CONSTANT. Orszag, Steven A. (Princeton Univ., N. J. Plasma Physics Lab.). July 1966. Contract AF49(638)-1555. 7p.

An approximate calculation of the Kolmogorov–Obukhov constant is made. It is indicated that the result is not sensitive to a wide range of turbulence approximations. (auth)

11631 (SU-IPR-105) STEADY-STATE THEORY OF AN INTERMEDIATE-PRESSURE DISCHARGE COLUMN IN A MAGNETIC FIELD. Ewald, H. N.; Crawford, F. W.; Self, S. A. (Stanford Univ., Calif. Inst. for Plasma Research). Oct. 1966. Contract AT(04-3)-326. 32p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A steady-state theory of a discharge column in a magnetic field is presented for the intermediate pressure range where the ion mean free path is neither much greater than, nor much less than, the discharge radius. The analysis is based on continuity and momentum transfer equations for the electron and ions, but in contrast to linear ambipolar diffusion theory the nonlinear ion inertia term is retained. In the plasma approximation, retention of this term gives rise to a plasma sheath boundary, where the density is non-zero and the potential finite located where the ambipolar drift velocity reaches the isothermal sound speed $[k(T_e + T_i)/m_i]^{\frac{1}{2}}$. Numerical solutions are presented for the profiles of density, velocity and potential, for planar and cylindrical discharges. These indicate that potential inversion can occur, and that under such conditions the potential rises to a maximum and then decreases towards the plasma/sheath boundary. With increasing pressure and magnetic field, the solutions tend to those obtainable from ambipolar diffusion theory. With decreasing pressure they approximate low-pressure discharge theory based on the use of the third moment equation for the ions. (auth)

11632 (SU-IPR-114) BEAM/PLASMA INTERACTION: A COMPARISON OF SYMMETRIC AND TRANSVERSE MODULATION. Abraham, E. E. (Stanford Univ., Calif. Inst. for Plasma Research). Nov. 1966. Contract AT(04-3)-326. 59p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Although a great deal of work has been carried out in the past on beam/plasma interactions, all of the numerical studies of the dispersion relation and nearly all of the experimental work have been for the axisymmetric mode. A derivation of the cold plasma dispersion relation is presented for an arbitrary number of azimuthal variations. A similar analysis is presented for the case of beam/plasma interaction in a warm plasma. The results of numerical computations of these dispersion relations are then presented and compared for the cases of axisymmetric and transverse modulation. The results of a stability analysis of the two cases are also presented. Experiments showing gain in both modes are described and additional confirmation that the transverse mode was observed is provided by a Faraday rotation experiment. (auth)

11633 (SU-IPR-124) STUDIES OF PLASMA OSCILLATIONS. Quarterly Status Report No. 28, September 1, 1966–November 30, 1966. Crawford, F. W.; Chodorow, M. (Stanford Univ., Calif. Inst. for Plasma Research). Dec. 1966. Contract AT(04-3)-326. 59p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Further studies on the following are reported: ion wave propagation and positive column instabilities, electron beam probing of plasmas, beam/plasma interactions, and positive column resonances and propagation. (M.O.W.)

11634 (UCRL-50002-66-1, pp 110-25) BERKELEY PLASMA RESEARCH. (California Univ., Livermore. Lawrence Radiation Lab.).

The purpose and principle of operation of the Homopolar Gun II device are discussed. Cross-field breakdown studies are discussed. Other discussions are presented on: end-stabilization of low-β interchange modes, spectroscopic studies, diffusion cross sections, and measurement of the electron correlation spectrum in a plasma. (M.O.W.)

11635 (NP-tr-1474) INTERACTION OF A PLASMA WITH A TRANSVERSE MAGNETIC FIELD. Zikov, V. G.; Sinitsa, N. G.; Stepanenko, I. A.; Tolok, V. T. Translated for Culham Lab., Abingdon, Eng., from pp 27-36 of Plasma Physics and Problems of Controlled Thermonuclear Fusion; Investigation of Plasma Blobs, Kiev, 1965. 11p. (CTO-290). Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.10 fs, $0.80 mf.

The motion of plasma jets in a transverse magnetic field was investigated. The dependence between the plasma velocity component perpendicular to the homogeneous magnetic field and the magnetic field strength was determined. (M.O.W.)

11636 (NP-tr-1489) COMPARISON OF THE ABSOLUTE INTENSITIES OF THE RADIATION OF A HIGH TEMPERATURE PLASMA IN THE VISIBLE AND SOFT X-RAY REGIONS. Bogen, P.; Schlueter, J. Translated for Culham Lab., Abingdon, Eng., from report JUL-381-PP, pp 59-64. 6p. (CTO-320). Dep. mn. JCL $1.10 fs, $0.80 mf.

Absolute measurements were made on the continuum intensity of the theta-pinch plasma in the visible and x-ray regions. The results indicate that, within an experimental error by a factor of 2, the measured intensity in the x-ray region can be attributed to pure bremsstrahlung. (M.O.W.)

11637 ACCELERATION OF CHARGED PARTICLES IN RANDOM ELECTROMAGNETIC FIELDS. Asseo, E.; Berthomieu, G. (Institut d'Astrophysique, Paris). Ann. Astrophys., 29: 689-96(Nov.-Dec. 1966). (In French).

The acceleration experienced by charged particles in a random electromagnetic field as a function of space and time is obtained by an all-order perturbation method. The random electric field is assumed to be induced by the turbulent motion of a plasma in a magnetic field. The velocity distribution function is shown to satisfy a Fokker–Planck type equation on a time scale large compared to the correlation time of the random medium. In the absence of magnetic field the results provide a check for Sturrock's results which are based on the a priori assumption that the velocity of the charged particles constitute a Markov process. (auth)

11638 EFFECT OF ION SHEATH ON RADIATION IN A MAGNETOIONIC MEDIUM. II. SOURCE CURRENT PERPENDICULAR TO THE MAGNETOSTATIC FIELD. Seshadri, S. R. (Sylvania Electronic Systems, Waltham, Mass.). Can. J. Phys., 45: 279-99(Feb. 1967).

The radiation characteristics of current sources situated along the axis of an infinite cylindrical column of free space and surrounded by a homogeneous, loss-free magnetoionic medium are discussed for the case in which the source current is perpendicular to the magnetostatic field. The static magnetic field is assumed to be parallel to the axis of the free-space column, which is an idealization of the ion sheath formed around the antenna in the ionosphere. Both a point electric dipole and a finite and continuous array of the same are investigated. The dependence of the radiation resistance of these sources on the frequency and the ion-sheath thickness is examined. Even in the limiting case of vanishing thickness of the ion sheath, the radiation resistances of these sources are found to be different from those corresponding to an unbounded plasma. In contrast to those in an unbounded magnetoplasma, the radiation resistance remains finite for all frequencies. For the source of finite extent having a current distribution that falls off sufficiently rapidly towards the ends, the radiation resistance is quite insensitive to the changes in the thickness of the ion sheath. The radiation-resistance curve, in general, has two peaks at the so-called dipolar resonant frequencies, which depend primarily on the strength of the magnetostatic field. These dipolar resonances, which are quite analogous to those in an axially magnetized plasma column, are found to become sharper as the radius of the free-space column becomes smaller. (auth)

11639 INVESTIGATIONS OF PLASMA FORMATIONS PRODUCED BY INTERACTION OF FLARES OF A PULSED DISCHARGE OF LARGE POWER. Kiselevskii, L. I.; Sultanov, M. A. Zh. Prikl. Mekh. Tekh. Fiz., No. 4, 96-8(July-Aug. 1966). (In Russian).

The interaction of plasma jets ejected from opposite electrodes in a pulsed discharge is discussed. This encounter can give rise to shock-compressed plasma regions, and the resultant plasma formations are of interest from the point of view of diagnostics of the discharge parameters. The discharges were produced in air at atmospheric pressure by discharging capacitor banks of 200 and 800 μF capacitance. The discharge voltage was 3 kV and the inductance of the discharge circuit was 1 μH. The structure of the discharge cloud was studied with a high-speed camera (SFR) under continuous sweep conditions and frame-by-frame photography, in which the shock-compressed regions of the plasma were registered in the form of zones of increased brightness. The photographs were taken at 125,000 frames/sec. The high-speed photographs disclosed the presence of sound oscillations in the compressed plasma regions produced by the interaction of the oppositely moving supersonic discharge flares. The oscillation frequency of these sound waves is of the order of 1.6×10^5 sec^{-1} and decreases slightly toward the end of the pulse. The photographs show clearly the bright regions corresponding to the flares and inclined strips corresponding to the sound perturbations. The

inclination of the strips makes it possible to determine the speed of sound in the plasma inside the shock-compressed region and consequently its temperature. Formulas for the determination of the temperature are cited. With the 800-μF capacitance, the speed of sound exceeded 2000 m/sec at ~50 μsec following the start of the discharge, and decreased with increase in time. The corresponding temperature was 14,000 K, and likewise decreased with time. A lower temperature was obtained when the capacitance was 200 μF. The results confirm the commonly held assumption that the temperature of the plasma is highest at the start of the discharge. It is concluded that this method can be successfully used to measure the time evolution of the temperature and the supersonic formations in a plasma. (ATD)

11640 NONLINEAR ELECTROMAGNETIC PHENOMENA IN A FLUID WITH A NONEQUILIBRIUM ELECTRIC CONDUCTIVITY IN AN ALTERNATING MAGNETIC FIELD. Kim, K. I. Zh. Prikl. Mekh. Tekh. Fiz., No. 4, 56-9(July-Aug. 1966). (In Russian).

Nonlinear electromagnetic effects in a dense plasma with an electric conductivity of $\sigma = c|j|^7$ during its motion in an alternating magnetic field are analyzed. It is assumed that the plasma parameters and variation limits of the specific values of (j,T) are such that the relationship $\sigma = c|j|^7$ is stable. Moreover, the properties of perfect of an ideal incompressible fluid are attributed to the plasma. (ATD)

11641 DISPERSION AND ABSORPTION OF HIGH-FREQUENCY AND LOWER HYBRID PLASMA WAVES. Glagolev, V. M. J. Nucl. Energy: Pt. C, 8: 811-12(Nov.-Dec. 1966).

In order to provide electromagnetic heating of plasma it is necessary for the wave to propagate in the plasma with a phase velocity which is near to the particle thermal velocity, and that its electric field amplitude is sufficiently large. Dispersion equations are obtained, taking absorption into account, for longitudinal hf and lower hybrid plasma waves, there being an arbitrary velocity distribution function for the electrons and ions. Two cases are considered: $k_\perp \rho_e \ll 1$, for $k_\perp \rho_i \ll 1$ and for $k_\perp \rho_i \gg 1$, where $k_\perp$ is the projection of the wave vector on an axis perpendicular to the magnetic field and lying in the plane passing through the direction of propagation and that of the magnetic field, ρ_e and ρ_i are, respectively, the electron and ion Larmor radii corresponding to their thermal velocities. (M.O.W.)

11642 RUNAWAY IN WEAKLY IONIZED PLASMAS. Stenflo, L. (Inst. of Physics, Uppsala). J. Nucl. Energy: Pt. C, 8: 665-73(Nov.-Dec. 1966).

A slightly ionized, spatially homogeneous gas is subjected to a weak constant electric field, and the relaxation of an arbitrary velocity distribution function for the electrons is studied. When the cross section for electron–molecule collisions decreases faster than $1/v^2$ for large velocities there exists no stationary solution of the Boltzmann equation. The runaway rate for different collision cross sections is calculated. As a further application the runaway rate for electrons in n–InSb at helium temperatures is estimated. (auth)

11643 COUPLING OF WAVES IN A HOT INHOMOGENEOUS ANISOTROPIC ELECTRON PLASMA. Lonngren, K. E.; Sjoelund, A.; Weissglas, P. (Royal Inst. of Tech., Stockholm). J. Nucl. Energy: Pt. C, 8: 657-63(Nov.-Dec. 1966).

The coupling of waves in a region of varying density in a hot anisotropic electron plasma is studied theoretically. The influence of the width of the inhomogeneous region and of the angle between the propagation vector and the static magnetic field are investigated. The latter parameter is shown to be very important. (auth)

11644 ACCELERATION OF GAS DURING ITS COMPRESSION IN A SYSTEM WITH ACUTE-ANGLED GEOMETRY. Voitenko, A. E. Zh. Prikl. Mekh. Tekh. Fiz., No. 4, 112-16(July-Aug. 1966). (In Russian).

The results of an experimental investigation of a device for producing high-velocity (50 to 90 km/sec), high-density gas jets, are presented. Brief descriptions of the device and the measuring techniques and apparatus are given. The effects of the shape of the chamber, the material and thickness of the chamber surface, the radius of the discharge tube and its shape, and the mass of the diaphragm on the jet velocity were investigated. A system composed of a shock wave, a reflected shock wave, and the resultant oblique shock wave is analyzed. An attempt is made to construct an approximate scheme for gas acceleration and compression by the plate and to carry out preliminary calculations of the gas flow. A numerical calculation carried out with air as the working gas at density $\rho_0 = 1.3 \times 10^{-3}$ gr/cm^3 and $\gamma = 1.3$ shows that densities behind the second and third shock waves are $\rho_2 = (\gamma + 1/\gamma - 1)\ \rho_1 = 80\ \rho_0$ and $\rho_3 = (\gamma + 1/\gamma - 1)\ \rho_2 \approx 600\ \rho_0$; the flow velocity in the tube is found to be v = 67 km/sec as against 70 km/sec obtained experimentally. (ATD)

11645 SPECTROGRAPHIC MEASUREMENTS ON AN ARC DISCHARGE. Barach, John Paul (Vanderbilt Univ., Nashville). J. Appl. Phys., 38: 64-7(Jan. 1967).

An arc discharge of 60-μsec duration and peak current of 2×10^4 A in an initial pressure of 3 torr of helium was studied spectroscopically. Time resolution was obtained by Kerr cell shuttering a 1.5-m spectrograph. The spectra were analyzed by Stark broadening and line-to-line intensity ratios. The arc was found to quickly evolve many times the initial density in wall and electrode materials, to decrease in degree of excitation after the first 10 μsec, and to lack thermodynamic equilibrium. The doubly ionized species were found to have roughly consistent temperatures of 7 ± 1.5 eV and the singly ionized species 4 ± 1.5 eV. The ratio between the two populations was more appropriate to excitation energies of 1 or 2 eV. (auth)

11646 MICROWAVE LOSS IN A REFLEX PLASMA DISCHARGE. Lichtenberg, A. J.; Govindan, P.; Woodyard, J. R. (Univ. of California, Berkeley). J. Appl. Phys., 38: 382-9(Jan. 1967).

The Q of a partially ionized plasma with fluctuating density, created by a reflex discharge, is determined by measuring the decay of microwave energy in a cavity coaxial to the plasma column. For the temperature and neutral gas pressure range of the experiment ($T_e \simeq 5$ eV, $p \simeq 5 \times 10^{-4}$ torr for a hot-cathode discharge) the experimental results agree with the theory that electron–neutral collisions dominate below a few percent ionization, and electron–ion collisions become important at higher ionizations. For cold-cathode discharges, with higher temperature, the electron–ion collisions are not significant. Virtual collisions with the ends of the interaction region also contribute to the loss for both hot and cold cathode discharges. Anomalous diffusion does not play a significant role in the microwave losses. The absolute magnitude of the experimentally determined collision time is lower than that calculated from the theory by a factor of three to four, which is in agreement with other measurements reported in the literature. For cold-cathode operation there remain some unexplained inconsistencies within the experimental results. (auth)

11647 NUMERICAL SELF-CONSISTENT FIELD APPROXIMATION TO THE INTERACTION OF AN ION BEAM WITH A PLASMA BOUNDARY. Seitz, W. S. (Itek Corp., Palo Alto, Calif.); Eilenberg, S. L. J. Appl. Phys., 38: 276-83(Jan. 1967).

Experimental results indicate that, under certain conditions, ion beams undergo severe deflection preceding the region where neutralization of the beam occurs. It is believed that this effect is related to the existence of a conducting plasma which forms in the neutral region of the beam. This effect is analyzed in terms of an axially symmetric model. The plasma is simulated by assigning appropriate boundary conditions at the plasma surface. The method consists of specifying the electric field on a trial boundary, then examining the resulting potential distribution for a unipotential surface on this boundary. A sequence of numerical solutions is found in which the trial boundary is perturbed for each iterate until the Cauchy conditions are satisfied. After the location and shape of this boundary are determined, the effect of variations in electrode potentials is examined and compared with observation. It is shown that under some conditions the plasma can significantly influence the structure of the ion beam. (auth)

11648 THE QUESTION OF LANDAU DAMPING IN ANISOTROPIC PLASMA. Bachmann, P. (Heinrich-Hertz-Institut, Berlin). Beitr. Plasmaphys., 6: 227-34(1966). (In German).

Starting from a well known form of the dispersion equation in quasistatic approximation some expressions for the Landau damping in anisotropic electron plasmas are derived. For special distribution functions they are of the form given by Jackson for a plasma without magnetic field. The essential part of the general stability criterion is derived. Using the Dawson model for Landau damping one obtains exactly the above expressions. (auth)

11649 KINETICS OF WAVES IN AN ANISOTROPIC PLASMA. Suramlishvili, G. I. Zh. Eksp. Teor. Fiz., 52: 255-63(Jan. 1967). (In Russian).

General relations are derived which yield the matrix elements of wave processes of arbitrary order involving free oscillations. The Lagrange function for a collisionless plasma is employed. The general formulas obtained are used for calculating some concrete quantities such as energy increase of Alfven waves produced as a result of decay of helicons and relaxation time in a "gas" of Alfven oscillations (3- and 4-wave processes are considered). (auth)

11650 THERMODYNAMICS OF A SYSTEM OF STRONGLY INTERACTING CHARGED PARTICLES. Klyuchnikov, N. I.; Triger, S. A. Zh. Eksp. Teor. Fiz., 52: 276-81(Jan. 1967). (In Russian).

The stability of a classical system of strongly interacting charged particles (dense plasma) is analyzed. It is shown that such a system may be stable in the fluid state if it contains neutral particles. A stability condition is derived. A formula is deduced which relates the concentrations of neutral and charged particles in such a system and is an analog of the Saha formula. (auth)

11651 THERMALIZATION OF ELECTRONS IN SHORT ARC PLASMA IN CESIUM VAPORS. Morgulis, N. D.; Dudko, D. Ya. Ukr. Fiz. Zh., 11: 1267-9(Nov. 1966). (In Ukrainian).

It is shown that it is possible to thermalize a stream of thermal electrons, which were accelerated in the region of the precathode potential jump, by means of the collective interaction with the Langmuir oscillations in a short arc discharge of cesium vapor. The experimental setup included a tungsten cathode electrically heated to a low temperature of 1000 to 1100°K so as to be covered with a film of cesium. The anode was a nickel disk at a distance of 7 mm from the cathode. A small, movable, cylindrical probe was used to measure the space distribution and spectrum of the plasma oscillations between the electrodes. The areas of disturbance varied with a change in charge concentration of the plasma. The data demonstrated the thermalization of thermoelectrons by the Langmuir oscillations of the cesium plasma. (TTT)

11652 EFFECTIVE CROSS SECTION OF ELECTRON SCATTERING IN PLASMA IN HELIUM AND ARGON WITH ADMIXTURE OF POTASSIUM VAPOR AND IN PURE POTASSIUM. Polushkin, I. N.; Dudko, Y. Ya. Ukr. Fiz. Zh., 11: 1269-71(Nov. 1966). (In Ukrainian).

He and Ar were used at a constant pressure p = 1.5 mm Hg std, and the K vapor addition was present at a pressure varying from 10^{-3} to 10^{-1} mm Hg std. The charge concentration n_e was varied from 10^{10} to 10^{11} cm^{-3}. The electron temperature T_e varied from 3000 to 5000°K. Two cylindrical probes were used to make the measurements. A plot of $\sigma(T_e)^{0.5}$ as a function of the average electron concentration n_e gave a straight line for potassium pressures of $p = 4 \times 10^{-3}$, 1.5×10^{-2}, and 4×10^{-2} mm Hg std. The total electron scattering cross-section by the neutral atoms and by the potassium atoms is given by the expression: $Q_{tot.} = n_a q_a + n_K q_K$. Values of the cross-section q (in cm^2) and the mobility μ (in cm^2/volt. sec) were determined, and were found to be respectively: 4.5×10^{-15} and 1.8×10^5 in the K–Ar system, 5.5×10^{-15} and 2.2×10^5 in the K–He system, 7×10^{-15} and 1.4×10^5 in pure potassium, 1.5×10^{-16} and 7×10^6 in the Ar–K system, and 5×10^{-16} and 2×10^6 in the He–K system. The first component is the main component. (TTT)

11653 HEAT CONDUCTIVITY OF UNDEGENERATED ELECTRON GAS IN INELASTIC SCATTERING OF ELECTRONS BY OPTICAL PHONONS. Gvozdovskii, I. V.; Shenderovskii, V. A. Ukr. Fiz. Zh., 11: 1247-8(Nov. 1966). (In Ukrainian).

With the use of the formulas of Kubo for the kinetic coefficients and mathematical methods of calculations, expressions are derived for the electrical conductivity, thermal emf and heat conductivity of an electron gas. The kinetic coefficients are readily calculated at high temperatures, and the ratio of heat conductivity to electrical conductivity $\chi/\sigma = 3\,(k/e)^2\,T$, that is, the Wiedemann–Franz law is obeyed. Calculations for the low temperature case show that the Wiedemann–Franz law also holds at low temperatures. The same method can be used to examine electron scattering on acoustical and optical phonons simultaneously. It turns out that the acoustical phonons do not contribute to the kinetic phenomena. (TTT)

11654 COMMENTS ON THE SOLUTION TO THE BOLTZMANN EQUATION FOR A WEAKLY IONIZED PLASMA. Ross, David W. (Univ. of Illinois, Urbana). Phys. Rev., 153: 244-9 (Jan. 5, 1967).

Hydrodynamic equations describing the motion of electrons in a weakly ionized plasma are derived formally from the Boltzmann equation by means of the Chapman–Enskog procedure. Two cases are considered, each with a stationary Maxwellian distribution ascribed to the atoms. In the first, electron–electron collisions are ignored, and the electron distribution function is determined by a balance between the electron–atom collisions and the electric field. There is only one conservation law, a hydrodynamic equation for the density. In the second case, electron–electron collisions are dominant, the distribution function is a local Maxwellian, and there are five conservation laws — equations for the density, drift velocity, and temperature. The equations used previously by the author to describe low-frequency oscillations are obtained in either case if the electron–atom collision frequency is independent of velocity. Otherwise, the zeroth-order equations are still exact, but first-order corrections are required, as illustrated by the example of the velocity-independent mean free path. The results are somewhat different from those of Davidov, who made different assumptions about the dominant collision mechanisms. (auth)

11655 PARAMETRIC EFFECTS OF RADIATION ON A PLASMA. Jackson, E. Atlee (Univ. of Illinois, Urbana). Phys. Rev., 153: 235-44(Jan. 5, 1967).

The parametric excitation of the modes of an infinite plasma by intense incident radiation is studied on the basis of the Vlasov equation. It is found that the modes can be driven into unstable oscillations for incident frequencies in the three regions $\omega_0 \simeq \omega_{pe}$, $\omega_{pe} + \omega_i$, and $2\omega_{pe}$, where ω_{pe} is the electron plasma frequency, and ω_i is the ion acoustic frequency. In the limit of weak intensities, the features of the two resonances $\omega_0 \simeq \omega_{pe} + \omega_i$ and $2\omega_{pe}$ are found to be in substantial agreement with the results of DuBois and Goldman. For larger intensities it is found that the resonance $\omega_0 \simeq \omega_{pe} + \omega_i$ is restricted to frequencies ω_0 which are not more than $4\omega_{pi}$ above or ω_i below this value, and has a maximum growth rate of $0.05\omega_{pe}$. The resonance near $\omega_0 \simeq \omega_{pe}$ is found to be dominated by collisional damping if $\gamma/\omega_{pe} > 10^{-4}$, and limited to a range of frequencies ω_0 of only $\omega_{pi}/100$. The present results do not generally agree with the results obtained by Silin. These results indicate that the usual harmonic approximation for the plasma is justified except in the above-mentioned frequency regions. (auth)

11656 DISSOCIATION OF H_2^+ AND H_3^+ IONS IN A LITHIUM PLASMA. Bottiglioni, F.; Coutant, J.; Gadda, E. (EURATOM-CEA, Fontenay-aux-Roses, France). J. Phys. (Paris), 27: 599-604(Sept.-Oct. 1966). (In French).

The cross section of proton production is measured for molecular ion beams of H_2^+ and H_3^+ in the energy range 20 to 50 keV, passing through a lithium plasma created by a vacuum arc in a magnetic field. The cross sections are $\sigma = 8 \times 10^{-16}$ cm^2 per electronic charge for 35-keV H_2^+ and 3×10^{-16} cm^2 for 35-keV H_3^+. They vary very slowly with the energy of incident ions in the range studied. (auth)

11657 SOLUTION OF SOME TRANSCENDENTAL EQUATIONS. Uberoi, C. (Indian Inst. of Science, Bangalore). J. Indian Inst. Sci., 48: 127-37(Oct. 1966).

While discussing the problem of transverse plasma oscillations excited by interpenetrating beams of positively and negatively charged particles, a large number of transcendental equations had to be solved. The following four are typical of them: $x \tanh x + (x^2 - \alpha^2)^{1/2} = 0$, $x \coth x + (x^2 - \alpha^2)^{1/2} = 0$, $x \tan x = C$, and $x \cot x + C = 0$. After discussing the existence of real, pure imaginary and complex roots using the well known theorems of algebra and complex variables, they were solved by graphical methods and the first few roots in each case are tabulated. (auth)

11658 ELECTRON LOSSES IN AN AFTERGLOW HYDROGEN PLASMA. Waidmann, G. (Kernforschungsanlage, Juelich, Ger.). Z. Phys., 198: 548-58(1967). (In German).

The time dependence of the electron density in the afterglow period of an electrodeless discharge in hydrogen was measured by means of 4- and 8-mm microwave interferometry. An exponential decay was observed in the late afterglow permitting the evaluation of a time constant in the density range from 10^{12} – 10^{10} electrons per cm^3. The decay time of the plasma was influenced by the discharge conditions. Electron losses could be explained by ambipolar diffusion and attachment to impurities. Two diffusion coefficients were found correlated to the discharge duration. The mobility value $\mu_0 = 10.1 \pm 1.0$ $cm^2/V \cdot sec$ calculated from the diffusion coefficient found for short discharge pulses agrees with Saporoschenkos mobility value $\mu_0 = 10.2$ $cm^2/V \cdot sec$ for the H_3^+ ion. A second mobility value $\mu_0 = 14.8 \pm 1.2$ $cm^2/V \cdot sec$ found for longer discharge pulses might refer to the H^+-ion. (auth)

11659 PLASMA OSCILLATIONS. Motz, H. (Oxford Univ.). Rep. Progr. Phys., 29: 623-74(1966).

A discussion is presented of the status of the Vlasov equation in statistical mechanics and a résumé is given of macroscopic equations obtained from the Vlasov equation which serve as a basis for the determination of all the modes of oscillations which the plasma can support. In the infinite uniform plasma longitudinal oscillations can exist uncoupled from transverse ones, and the former are investigated in detail. Experiments on acoustic waves are reviewed and the theory which takes account of boundary conditions is found to be related to that of ionization waves. The macroscopic theory does not include collisionless damping, as originally discovered by Landau, and this is treated in some detail. Thereafter beam instabilities are reviewed and classified. A short discussion is presented of resonance oscillations in hot nonuniform plasmas and cyclotron harmonic phenomena. (auth)

11660 THE ELECTRODE-LESS GENERATION AND/OR ACCELERATION OF PLASMA. (to Siemens-Schuckertwerke

Aktiengesellschaft). British Patent 1,049,667. Nov. 30, 1966. Priority date Mar. 8, 1963, Germany.

An electrodeless method is described for generating and/or accelerating a plasma. Two field coils are mounted on and coaxial with a tube of insulating material and are spaced one from the other in a direction along their common axis. An induction coil of low self-inductance is coaxial with the tube and is located between the two field coils. An electric current is passed around the two field coils as to set up opposed respective magnetic fields therein and to establish between the field coils a cusp field which has a radial component in the region of the induction coil. A pulse of electric current is passed round the induction coil, whereby plasma is generated and/or accelerated in a direction along the common axis. (M.O.W.)

Production of Plasma

11661 (IPP-3/44) EXPERIMENTELLE UNTERSUCHUNGEN AN EINEM WASSERSTOFF-LICHTBOGEN IM ACHSENPARALLELEN MAGNETFELD. (Experimental Investigations of a Hydrogen Arc in an Axial Magnetic Field). Mahn, C.; Ringler, H.; Zankl, G. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Nov. 1966. 43p. (In German). Dep. mn.

In a stationary dc arc, the electric power input is balanced essentially by heat conduction losses in radial direction. These losses increase greatly with temperature and thus they limit the axial temperatures attainable with reasonable power input. An experiment is described in which considerably higher plasma temperatures have been obtained by reducing the coefficient of heat conduction with a superimposed axial magnetic field. At arc currents of about 2 kA and a magnetic field of 10 kG, temperatures in the middle of the arc of 10 eV were reached. The measured temperature, pressure, and velocity of the hydrogen plasma are compared with calculated values. In particular, the coefficient of heat conduction perpendicular to a magnetic field has been determined by measuring the radial temperature profile and the electric field strength. The results agree with theoretical predictions. (auth)

11662 PROPAGATION OF WEAK SHOCK WAVES IN A MAGNETIC FIELD. Lugovtsov, A. A. Zh. Prikl. Mekh. Tekh. Fiz., No. 4, 91-3(July-Aug. 1966). (In Russian).

The magnetohydrodynamic problem solved is that of propagation of weak shock waves in an inhomogeneous conducting medium in the presence of a magnetic field. The width of the perturbed region is assumed small compared with the characteristic dimensions of the problem. The magnetic Reynolds number is also assumed small, so that the induced magnetic field can be neglected. The conductivity of the medium is assumed isotropic. The method used is essentially that of characteristics. Equations for the discontinuities of the pressure, density, and velocity on the shock front are obtained and are shown to go over into the standard equations of ordinary gas dynamics when the magnetic field or the electric conductivity vanish. (ATD)

11663 ELECTRIC FIELD IN THE PLASMA BEHIND A STRONG SHOCK WAVE. Borman, V. D. J. Nucl. Energy: Pt. C, 8: 810-11(Nov.-Dec. 1966).

The electrical signals, which are registered by ring probes in a shock tube, may be divided into two types: those traveling ahead of the shock wave and those corresponding to the passage of the region between the shock front and the contact discontinuity (the slug) past the point of observation. The reason an electric field arises in the slug of a shock wave in a monoatomic gas is discussed; this corresponds to the second type of signal. (M.O.W.)

11664 THEORY OF THE NON-STATIONARY ARC COLUMN. Phillips, R. L. (Univ. of Michigan, Ann Arbor). Brit. J. Appl. Phys., 18: 65-78(1967).

The equations that describe the behavior of a time-unsteady plasma column have been simplified by neglecting energy transfer by radiation and convection. Furthermore, the thermal diffusivity of the plasma was assumed to be constant and a simplified expression for the electrical conductivity was adopted. Thus the energy equation was cast into a universal form, requiring the specification of only two parameters to obtain solutions. Although some approximate closed form solutions were obtained it was necessary to solve the general a.c. arc problem on a digital computer. In view of the good agreement between the theoretically derived voltage waveforms and those found from a specially designed a.c. cascade it is concluded that the behavior of the low current a.c. arc can be described by the solution of a complicated heat conduction problem. These solutions have the advantage over older theories that they can be directly related to measurable or calculable quantities that characterize a particular gas. (auth)

11665 SHOCK-WAVE-GENERATED PLASMAS AS LIGHT SOURCES FOR OPTICAL PUMPING. Buser, R. G.; Papayoanou, A.; Ramm, D. (Inst. for Exploratory Research, Fort Monmouth, N. J.). J. Appl. Phys., 38: 28-34(Jan. 1967).

Electrodeless discharges in coaxial tubes, capable of holding a laser crystal in the center, have been studied to obtain a measure of the energy coupled into the tube, to understand the dynamical processes, and to quantitatively determine the radiation emitted by the tube. The energy coupling and emitted radiation have been found to depend on the voltage stored on the capacitor, the primary coil dimensions, the fill gas and fill-gas pressure, and the tube dimensions. The dominant dynamical processes are those due to strong cylindrically imploding shock waves. Radiation emitted is found to be due to particles liberated from tube walls as well as that of the fill gas. Curves of radiation intensity vs wavelength, as well as spectral pictures and calculations of spectral matching coefficients, indicate the possibility of pumping very high powers into ruby crystals. (auth)

11666 CHARGED PARTICLE OSCILLATOR. McIlraith, A. H. (National Physical Lab., Teddington, Eng.). Nature, 212: 1422-4 (Dec. 24, 1966).

During an investigation of electron paths in an x-ray tube by means of a rubber gravitational model, it was found that when an isolated pair of rods is pressed into the rubber a ball released from rest a large distance from them passes between them many times before having a collision. This observation suggested that in the corresponding electrical model comprised of a pair of positively charged infinitely long parallel electrodes a single negatively charged particle will follow an oscillatory path which always passes between the electrodes. Here it is assumed that the particle has no collisions with other particles and does not lose energy by radiative or other means. The proof of this given here holds not only for the field previously postulated but also for any other force field the corresponding potential field which possesses a single saddle point with three planes of symmetry and the lines of force of which at a distance are asymptotic to lines passing through the saddle point. (auth)

Stability of Plasma

Refer also to abstract 11626.

11667 (CLM-R-63) ADIABATIC INVARIANTS AND THE EQUILIBRIUM OF MAGNETICALLY TRAPPED PARTICLES. 2. MATHEMATICAL DETAILS. Hastie, R. J.; Taylor, J. B.; Haas, F. A. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Aug. 1966. 67p. Dep. mn. BIS $1.80. HMSO 9s. 0d.

The conditions for plasma equilibrium in an arbitrary magnetic field and their relation to the lowest order particle adiabatic invariants, and the form of the higher order contributions to these adiabatic invariants are discussed. The equilibrium conditions are investigated in a systematic way: as the time scale of equilibrium is increased the constraints on the distribution function become more severe until they culminate in the requirement that it be a function of the lowest-order adiabatic invariants. It is shown that this discussion of equilibrium leads to a convenient and novel way of generating the adiabatic invariants, not just to lowest order but including higher order contributions, for which a recurrence formula is derived. When the first correction to the longitudinal invariant $J = \oint v_{||}\, ds$ is computed some interesting differences are found between the case of particles oscillating between mirrors and that of particles circulating round closed field lines. The effect of electric fields and the extension of the calculations to time dependent magnetic fields, leading to the third adiabatic invariant (the flux invariant) are discussed. The case of toroidal magnetic fields possessing magnetic surfaces and the form of longitudinal invariant appropriate in such a field are considered. In the case of small rotational transform a modified line integral for J leads to a convenient description of particle motions in toroidal systems, including the effects of both rotational transform and guiding center drifts. (auth)

11668 (IPP-1/55) VORLAEUFIGE UNTERSUCHUNG EINES GEWELLTEN THETA-PINECHES ("LIMPUS") AN DER BATTERIE ISAR I. (Preliminary Investigation of a Corrugated Theta Pinch ("Limpus") at Isar I). Andelfinger, C.; Decker, G.; Fuenfer, E.; Hermansdorfer, H.; Keilhacker, M.; Remy, E.; Ulrich, M.; Wobig, H.; Wolf, G. H. (Institut fuer Plasmaphysik, G.m.b.H., (Garching (West Germany)). Oct. 1966. 21p. (In German). Dep. mn.

The stability properties of a corrugated theta-pinch plasma are of interest in connection with the periodically bulging M + S configurations. In a preliminary experiment at the Isar I bank a step-like theta-pinch coil was used to produce the corrugated plasma column ("Limpus"). The measured amplitude of corrugation of the

plasma surface is nearly as large as that of the inner coil surface. This result agrees with numerical calculations of the magnetic field. The eccentric final position of the pinched plasma in the normal straight geometry is not influenced by the corrugated field, the plasma reached its final position more quickly, however. Smear camera pictures of discharges in 20 μD_2 show filaments which leave the main plasma column. This effect occurs around the regions of maximum plasma diameter and it is taken as an indication of instability. Smear camera pictures of discharges in 10 μD_2 give no indication for instabilities. The ion temperature is in the range of 3 keV and does not differ from the normal case with straight magnetic field. (auth)

11669 (IPPJ–53) PARTICLE ASPECT ANALYSIS OF DRIFT WAVE INSTABILITY. Terashima, Y. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Nov. 1966. 16p. Dep. mn.

The physical mechanism of drift wave instability is studied from the particle point of view by following the method used by Dawson in his theory of Landau damping. The plasma particles are divided into two groups, resonant particles and nonresonant particles. Assuming that a drift wave starts initially while resonant particles are undisturbed, the trajectories of the particles are computed within the framework of linear theory. Such a drift wave of longitudinal mode is considered that propagates obliquely to a static magnetic field and in the plane normal to density gradient. Its phase velocity along the magnetic field, $\omega/k_{||}$, is assumed to be greater than the ion's mean velocity but smaller than the electron's one. Resonant particles in this case are those electrons which have the velocities near to $\omega/k_{||}$. It is shown that the rate of energy change of the resonant electrons consists of two terms: one is the usual form of Landau damping due to $\vec{E}_{||}$ and the other is the term due to $\vec{E}_{\perp} \times \vec{B}_0$ drift, where $\vec{E}_{||}$ and $\vec{E}_{\perp}$ are the components of the electric field of the wave along and across the magnetic field $\vec{B}_0$. The latter is responsible for the unstable motion of the wave. Major part of the wave energy is contained in the form of oscillatory motions of the nonresonant electrons. (auth)

11670 (UCRL–50002-66-1, pp 126-48) THEORETICAL AND BASIC EXPERIMENTAL PLASMA PHYSICS. (California Univ., Livermore. Lawrence Radiation Lab.).

Brief discussions are reported on the following: electrostatic instabilities, two-stream cyclotron instability in the presence of plasma, convective vs. nonconvective instabilities, field-curvature and temperature-gradient effects on the ion cyclotron drift instability, early time development of strong instabilities, plasma kinetic equations, suppression of the negative-mass instability by the use of inductive walls, nonlinear theory of negative-mass instability, Diocotron instability in cylindrical geometry, Cherenkov radiation from current loops, calculation of toroidal magnetic-field configurations, computational study of electron injection in Astron device, a computation for studying the formation of the Astron E-layer, trapping mechanisms and stochastic processes in the Astron device, trapping and buildup of the E-layer in Astron, population distributions in charge exchange, a high-sensitivity Schlieren technique, and atomic scattering and cross section measurements. (M.O.W.)

11671 EFFECT OF LONGITUDINAL MAGNETIC FIELDS ON MOVING STRATA. Zaitsev, A. A.; She-Midon. Vestn. Moskov. Univ., Ser. III: Fiz. Astron., No. 4, 98-101(July-Aug. 1966). (In Russian).

The effect of longitudinal magnetic field increase and dispersion of moving strata was investigated. In positive discharge columns in He produced in tubes 70 cm in length and with an internal diameter of 0.4 cm at pressures of 0.8 mm Hg, the lower boundary for the formation of the stratum was 240 mA. This gave the possibility of investigating both the naturally and artificially excited mobile strata near the instability boundaries of the homogeneous state of the positive column. The growth of the moving strata, its dispersion, and the decrease of the voltage along the strata were calculated. The results are tabulated. (J.S.R.)

11672 ON STRONG TURBULENCE OF AN INHOMOGENEOUS WEAKLY IONIZED PLASMA IN CROSSED ELECTRIC AND MAGNETIC FIELDS. Kopecky, V.; Vaclavik, J. (Inst. of Plasma Physics, Prague). J. Nucl. Energy: Pt. C, 8: 645-56(Nov.-Dec. 1966).

Instability of the drift-dissipative type, of a weakly ionized nonisothermal plasma in crossed electric and magnetic fields has been studied in the quasi-classical approximation for two cases: (a) $\Omega_e\tau_e \gg 1$, $\Omega_i\tau_i \gg 1$, (b) $\Omega_e\tau_e \gg 1$, $\Omega_i\tau_i \ll 1$. The increment and frequency of the instability of such a plasma against potential disturbances have been deduced in the linear approximation. Equations of strong turbulence evolved with the aid of Mikhailovskii's diagram method have been used in estimating the maximum value of the spectrum function of the electric field of oscillations and of the coefficient of turbulent diffusion. A set of equations of strong turbulence in the dimensionless form is presented for computer analyses. (auth)

11673 GENERALIZED FORMULATION OF ELECTROSTATIC OSCILLATIONS AND STREAMING INSTABILITIES IN BOUNDED AND UNBOUNDED INHOMOGENEOUS VLASOV PLASMAS. Lee, Kai Fong (Cornell Univ., Ithaca, N. Y.). J. Appl. Phys., 38: 235-42(Jan. 1967).

A general formulation for the study of electrostatic oscillations and streaming instabilities in bounded and unbounded Vlasov plasmas with transverse density gradients in a strong axial magnetic field is presented. It is found that the behavior of the plasma depends on a parameter which is a function of geometry, scale of inhomogeneity, and wavelength. Using this formulation, several experimentally realistic configurations have been studied. Two results obtained are of special interest. They are (1) for waves with the same wavelength, a density inhomogeneity and/or boundary increase Landau damping. (2) Under appropriate conditions, depending on the geometry and the degree of inhomogeneity, it is not possible to excite the two-stream instability for any drift velocity. Previous theories of uniform plasmas appear as special cases in this general treatment. (auth)

11674 DRIFT INSTABILITY IN A PLASMA LOCATED IN A HIGH FREQUENCY ELECTRIC FIELD. Fainberg, Ya. B.; Shapiro, V. D. Zh. Eksp. Teor. Fiz., 52: 293-308(Jan. 1967). (In Russian).

The possibility of stabilizing drift instabilities of an inhomogeneous plasma by applying a high-frequency homogeneous electric field along the direction of the magnetic field lines is discussed. It is demonstrated that in the case of collisionless drift instability, stabilization by a longitudinal electric field is possible for $k_z v_{Ti} \ll \omega \ll k_z v_{Te}$ and for $\omega \gg k_z v_{Te}$ (ω and k_z are the frequency and projection of the drift oscillation wave vector on the direction of the magnetic field; v_{Te} and v_{Ti} are the electron and plasma ion thermal velocities). The conditions which must be imposed on the external field frequency to ensure that the high frequency field is a stabilizing one and the field amplitudes required for stabilization are found. The possibility of high frequency stabilization of drift-dissipative instability is also considered. (auth)

11675 FLUTE INSTABILITY OF THE COLUMN OF A STRONGLY INHOMOGENEOUS RAREFIED PLASMA. Arsenin, V. V. Zh. Eksp. Teor. Fiz., 52: 218-22(Jan. 1967). (In Russian).

Flute oscillations of the column of a plasma of extreme inhomogeneity in which the thickness of the transition layer between the plasma and vacuum is two Larmor radii are considered. It is shown that the $|m| = 1$ mode is not stabilized even by a large (compared to the column radius) Larmor radius. An example is presented of a distribution which is unstable for an arbitrarily small value of gravitation imitating curvature of the magnetic field lines relative to disturbances of higher modes $|m| > 1$. (auth)

Thermonuclear Processes

Refer also to abstract 10519.

Shielding

Refer also to abstract 11287.

11676 (AD–630121) NEW INITIAL VALUE METHOD FOR INTERNAL INTENSITIES IN RADIATIVE TRANSFER. Kagiwada, H. H.; Kalaba, R. E. (RAND Corp., Santa Monica, Calif.). Mar. 1966. 26p. (RM–4906-PR). CFSTI $3.00 cy, $0.65 mn.

A classical problem in mathematical physics is determination of the intensity of the diffuse radiation field produced in a finite homogeneous slab which absorbs and scatters radiation isotropically, the incident radiation being uniform parallel rays. A new method which has analytical and computational advantages is presented. First, a decomposition formula is derived which expresses the internal intensity function terms of Chandrasekhar's X and Y functions, the source function J, and two new functions, b and h, which represent the internal intensities due to isotropic sources at the top and bottom. The effect of this is that the internal intensity function is expressed in terms of functions of fewer independent variables. Since adequate tables of X, Y, and J are available, the remaining task is to devise an effective method for computing b and h. This is done by deriving differential-integral equations which they satisfy, and by employing Chandrasekhar's method of finite ordinates. This leads to the integration of an initial value problem for a system of ordinary differential equations, a task for which the modern digital computer is admirably suited. Some typical results and a comparison, where pos-

sible, against other calculations are presented. On the mathematical side, the method for converting certain problems involving two-point boundary conditions or, singular integral equations into stable initial-value problems is shown. Such transformations are of major importance in mathematical physics and engineering. (auth)

11677 (AD-643754) ATTENUATION OF NITROGEN-CAPTURE GAMMA RAYS IN CONCRETE. Johnson, W. Reed (Virginia Univ., Charlottesville). Nov. 1966. 70p. (NDL-TR-82).

Shielding experiments were performed to measure the attenuation by concrete slabs of nitrogen-capture gamma radiation. A collimated capture gamma-ray beam was produced by placing a Be_3N_2 target in the reactor end of a tangential beam hole. A 2-inch diameter beam with an average intensity of approximately 43 mR/h was allowed to impinge at the center of an ordinary concrete-slab shield; this shield was approximately $4\frac{1}{2}$ feet on a side and ranged from 4- to 24-inches thick. The slabs of the shield were rotated to allow measurements at beam angles of incidence of 90°, 60°, and 45°. The gamma-ray exposure was integrated in a plane behind and parallel to the shield for each shield thickness and angle of incidence. The integrated exposure was determined by summing individual measurements made in a regular pattern in the plane behind the shield. Gamma-ray exposure measurements were obtained with an anthracene scintillation crystal, 1 inch in diameter, $\frac{1}{2}$-inch thick, and surrounded by $\frac{1}{2}$ inch of lucite to provide equilibration for energetic secondary electrons. Amplified pulses from the crystal were electronically integrated to provide digital, exposure-proportional output. The dosimetry system was calibrated directly against ^{137}Cs and ^{60}Co gamma rays. When exposed to the capture gamma-ray beam, the system gave the same response as a standard ion chamber (R-meter) covered with $\frac{1}{2}$ inch of lucite. Measurements of total exposure attenuation in narrow-beam geometry indicated energy-independent response of the detector. Beam spectrum measurements made with a sodium iodide crystal indicated that a large fraction of the beam exposure (48 percent) was due to capture gamma rays from aluminum and hydrogen in the reactor reflector. Shielding measurements were made with a beam of these capture gamma rays and their contribution was subtracted from the exposure of the primary beam. Narrow-beam geometry, the anthracene dosimeter, and a NaI crystal to isolate specific photon energies were used to measure total attenuation for both beams. The results of moments-method calculations of gamma-ray exposure in concrete by Spencer and Lemkin were compared with the results obtained in the experiment. Agreement is not particularly good, the University of Virginia experimental attenuation results being greater in every case. One reason for the difference may lie in the method of applying calculated infinite-medium results to experimental measurements in finite-slab geometry. The determination of the exact spectrum of the gamma-ray beams to use in the calculation, particularly at the low-energy end, represents another potential source of disagreement. (auth)

11678 (JAERI-4038) PROGRESS REPORT OF SHIELDING INVESTIGATIONS IN JAPAN. Shindo, M. (ed.) (Japan Atomic Energy Research Inst., Tokyo). 1966. 32p. Dep. mn.

The main results of shielding studies made in Japan since the spring of 1964 are presented. Theoretical and experimental research on gamma-ray problems, neutron problems, and duct-streaming problems as well as the state of the mockup tests of the first Japanese nuclear ship are described. (auth)

11679 (ORNL-3854) THE EFFECT OF CHARGED-PARTICLE SLOWING DOWN ON THE NUCLEAR CASCADE IN STEEL INITIATED BY 19.2-GeV/c PROTONS. Alsmiller, R. G. Jr.; Alsmiller, F. S.; Barish, J. B. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 15p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A numerical solution to the one-dimensional nucleon-meson cascade equations is obtained for the case of the nuclear cascade in steel initiated by 19.2-GeV/c protons under the assumption that proton and charged pion slowing-down may be neglected. This solution is compared to the solution obtained when slowing-down is included and large differences in the low energy (~ 100-MeV) particle intensities are found. (auth)

11680 FLUCTUATIONS IN SHOWERS PRODUCED BY 45- TO 330-MeV ELECTRONS. Zaimidoroga, O. A.; Prokoshkin, Yu. D.; Tsupko-Sitnikov, V. M. Zh. Eksp. Teor. Fiz., 52: 79-89(Jan. 1967). (In Russian).

Fluctuations in electron-photon showers produced in lead by 45-, 130-, 230-, and 330-MeV electrons have been studied by aid of a cloud chamber with internal plates. Fluctuations of shower energy losses as a function of absorber thickness t are determined for the energy of 330 MeV. The half-width of the energy loss curve changes from 65% for t = 10.2 g/cm² to 30% for t = 49.8 g/cm². The half-width of the loss curve is proportional to $E_0^{-\frac{1}{4}}$. The shower distribution with respect to number of electrons at various depths of cascade development have been obtained. The distributions can satisfactorily be described by a combined Poisson distribution (one each for showers with odd and even numbers of electrons). An analysis of correlation of fluctuations of the number of electrons at various thicknesses of the absorber shows that the correlation strongly decreases after traversal of a lead layer of 6 ÷ 8 g/cm², irrespective to the primary energy of the electrons. All shower characteristics were obtained at the cut-off of the secondary electron spectrum at ~1 MeV. (auth)

11681 ENERGY CHARACTERISTICS OF X RADIATION AT MAXIMUM 40 TO 120 kV. Stavitskii, R. V. At. Energ. (USSR), 21: 306-8(Oct. 1966). (In Russian).

The energy characteristics of half-thickness layers of water, brick, and concrete media for shielding against direct and scattered x radiation were measured at maximum intensity of 40 to 120 kV. The analysis of energy characteristics of direct and scattered radiation passing through 20 cm of water showed that with the tube range from 40 to 120 kV maximum with additional 2 mm aluminum filter the effective energy of the wide beam is 40 to 60 keV and of the narrow 40 to 95 keV; the effective energy of the radiation scattered at 90° is close to the energy of the primary beam in free air (23 to 34 keV). The energy characteristics for x-rays passing a 12.5-cm layer of bricks or 12 cm of concrete were measured only for wide primary beams. Half-thickness attenuation waves for the first and second layers practically coincide at intensities below 80 to 90 kV max. The indicated thicknesses do not have sufficient protective properties. However, results indicate that with uniform radiation passing through brick and concrete of this thickness the effective energy corresponds to about $\frac{3}{4}$ of absolute intensity in the tube. (R.V.J.)

11682 VELOCITY DISTRIBUTION OF ELECTRONS SCATTERED FROM A SLAB BY THE GAMMA FLUX FROM A NUCLEAR EXPLOSION. Taylor, C. D. (Sandia Corp., Albuquerque, N. Mex.). Nucl. Sci. Eng., 26: 347-53(Nov. 1966).

A slab is considered to be bombarded normally by a flux of gamma rays from a nuclear explosion. As a result of this bombardment, electrons are scattered from the slab with a distribution of velocities. An approximation to the velocity distribution is obtained with the Klein–Nishina theory of the Compton process, the Bethe formula for average energy loss per unit path length of an electron penetrating matter, and a correction factor accounting for the multiple scattering of the electrons. The theoretical study reveals that the electrons are scattered out of the slab predominantly into the direction of propagation of the incident gamma rays. The velocity distribution of the electrons upon emerging from the slab is peaked near the high velocity end of the spectrum; it is also shown to be independent of the slab thickness, provided the thickness is greater than the maximum range of the recoil electrons but less than the mean free path of the gamma rays. Numerical results are obtained that confirm the statements of Karzas and Latter. (auth)

11683 MEASUREMENTS AND SINGLE-VELOCITY CALCULATIONS OF DIFFERENTIAL ANGULAR THERMAL-NEUTRON ALBEDOS FOR CONCRETE. Maerker, R. E.; Muckenthaler, F. J. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 26: 339-46(Nov. 1966). (ORNL-P-2047).

Single-velocity Monte Carlo calculations and measurements were performed to determine the differential angular thermal-neutron albedos for a reinforced concrete for monodirectional beams of incident thermal neutrons. Preliminary calculations using a statistical estimation technique indicate up to 50 scatterings should be followed for each neutron to produce good estimates of the differential albedos, and up to 100 scatterings to produce good estimates of the capture gamma differential dose albedos. Deviation between experiment and calculation can be reduced to an average of 5.1% for 72 points of comparison if an anisotropic scattering law for water deduced from earlier Argonne National Laboratory measurements is assumed. (auth)

11684 ANGULAR DISTRIBUTIONS OF LOW-ENERGY NEUTRONS LEAKING FROM VARIOUS SCATTERING MATERIALS. Verbinski, V. V. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 27: 67-79(Jan. 1967). (ORNL-TM-1078(Rev.)).

Experiments in which a wide range of scattering materials in the form of slabs were bombarded by reactor neutrons showed that the angular distribution of low-energy (<5-eV) neutrons leaking from the opposite side of a slab is independent of the source term and of the slab thickness for thicknesses greater than some minimum thickness z_{min}. In the case of pure lead, pure water, and mildly poisoned water, the resulting distributions are in agreement with the Fermi expression $\Phi(\mu) = 1 + \sqrt{3}\,\mu$. The results for pure lead are also in excellent agreement with one-velocity

calculations. An imperfect experiment with poisoned lead is in qualitative agreement with one-velocity calculations. The angular distribution for LiH is described by $\Phi(\mu) = 1 + A\mu$, where A is less than $\sqrt{3}$ for subcadmium neutrons and greater than $\sqrt{3}$ at 1.5 and 5 eV. For energies above 5 eV, a Monte Carlo calculation on LiH showed that A continues to rise to a peak value of about 2.5 at 30 eV, after which it decreases to a value of $\sqrt{3}$ above 10^3 eV, where the absorption cross section of lithium becomes negligible. The applicability of two neutron transport codes that numerically integrate the Boltzmann transport equation was tested in additional calculations for LiH and water. Although the two codes have been used successfully in other types of shielding calculations, they yielded angular distributions for the same material that disagreed with each other, as well as with some experimental data. This suggests that the development of neutron transport codes should include angular distribution tests. (auth)

11685 STUDY OF SPECTRA AND DOSES GENERATED BY A MONOENERGETIC NEUTRON SOURCE IN IRON–WATER SHIELDING. Barsukov, O. A.; Avzyanov, V. S.; Ivanov, V. N. At. Energ. (USSR), 21: 27-35(July 1966). (In Russian).

Multigroup calculations were made of the passage of neutrons, emitted by a monoenergetic neutron source, through water, iron, and iron–water systems of finite dimensions. Neutron spectra in the shield layer were calculated by twenty-group diffusion-transport approximations. The high-energy region of the spectrum was investigated in detail, and some singularities of the migration and neutron retardation processes in the shielding layers were studied. The dose curve D(r) for neutrons with various energies was constructed. The principle of superposition of neutron distribution was developed from the calculated data for sources with arbitrary spectra. (tr-auth)

11686 IMPROVED MONTE-CARLO CALCULATION OF THE NUCLEON–MESON CASCADE IN SHIELDING MATERIAL. I. DESCRIPTION OF THE METHOD OF CALCULATION. Ranft, J. (CERN, Geneva). Nucl. Instrum. Methods, 48: 133-40(Feb. 11, 1967).

The nucleon-meson cascade in shielding material is calculated by a Monte-Carlo method. The principle of the method and the physical data used in the calculation are described. For primary proton beams in the GeV region the three dimensional densities of proton, neutron, and pion stars inside the shielding material are calculated as well as the total start density (sum of proton, pion and neutron star densities) and the total track density (sum of proton, pion and muon track densities). The momentum spectra and the angular distributions of protons, pions and neutrons as function of the depth inside the shielding material are also calculated. The results, which will be described in a second paper, are in good agreement with the available experimental data. (auth)

11687 THERMAL NEUTRONS IN DUCTED SHIELDS. Channon, Frederick Robert. Tucson, Ariz., Univ. of Arizona, 1966. 172p.

Thesis.

The behavior of thermal neutrons in shields containing ducts was studied experimentally and compared with theoretical models. A Van de Graaff accelerator was used as a source of fast neutrons. These neutrons were slowed to thermal energies in a large block of graphite and allowed to strike a water tank. This tank, which represented the shield, was designed to allow the mounting of various size cylindrical ducts extending through the shield. The measurement of the relative thermal neutron flux in a duct was performed by use of both indium foils and a BF_3 probe. In addition to measuring the total flux, a source separation technique was used to isolate experimentally the various flux components. Sheets of cadmium were used to absorb the neutrons coming from various sources in turn. This permitted determination of the three flux components: Direct flux, neutrons which enter the duct mouth and travel in a straight line to the detector; scattered flux, neutrons which enter the duct mouth, but scatter from the duct walls before reaching the detector; penetration flux, neutrons which enter the shield away from the duct, but penetrate to the detector. Several parameters which influence the radiation attenuation were varied to provide an extensive test of the calculational models. Duct diameters from 1-⅛″ to 4″ were considered. The shield absorption properties were altered by dissolving various amounts of boric acid in the water. In addition, the duct cross-sectional shape was changed by partially flooding the interior of the duct. The results of these experiments indicated that the direct flux has an asymptotic form inversely proportional to distance squared. For sufficiently long ducts the direct flux and the total flux are nearly equal. At intermediate distances in a duct either the scattered flux or the penetration flux may produce the most significant contribution to the total flux. Each of these components reaches a peak a short distance down a duct, and then attenuates more rapidly than the direct flux. Successful calculational models were developed for each of the flux components. These permitted determination of the total thermal neutron flux within a factor of 1.3 at distances greater than two to three duct diameters from the mouth. The direct flux was determined by deriving a geometric formula for the radiation near a disc source emitting with a cosine angular distribution. The effect of the scattered flux was well matched by using a Simon-Clifford analysis in which the current reflected from the duct walls has a cosine angular distribution. A model for calculating the effective total albedo was found. The source for the penetration component was represented by a continuous current of neutrons along the duct wall. These neutrons entered the side of the duct and travelled to the detector. The results of the duct shape study indicated that noncircular ducts exhibit an effective radius which can be described by an empirical expression. The results of this study provide a good understanding of the general behavior of radiation in ducts, as well as a reliable, simple calculational model for thermal neutrons. (Dissertation Abstr.)

Solid-State Physics

Refer also to abstracts 11266, 11305, 11306, and 12027.

11688 (IS-T-109) RELATIVISTIC ENERGY BANDS AND FERMI SURFACES FOR SOME HEAVY ELEMENTS. Keeton, Stewart Charles (Ames Lab., Iowa). Nov. 1966. Contract W-7405-eng-82. 126p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

A theoretical investigation is presented of the relativistic effects on the band structure of heavy metals, i.e., metals composed of heavy elements. The theoretical method used in the calculations was the relativistic augmented-plane-wave method. Relativistic and nonrelativistic energy bands are compared for Lu, Ac, and Th. The relativistic effects are particularly striking for Ac and Th. One relativistic effect that is quite apparent from the energy bands presented here is the tighter binding of the atomic electrons with low angular momentum. This has the effect of moving the s-like band in Ac and Th down by about .2 Rydberg at the center of the Brillouin zone. The energy bands and Fermi surfaces of Hg, Th, and Dy are also presented. Available experimental de Haas-van Alphen and magnetoresistance data are compared with theoretical predictions calculated for Hg. The agreement is good. The experimental density of states at the Fermi level obtained from specific heat and magnetic susceptibility measurements for Th are compared with the calculated value for Th found in this investigation. The agreement implies that electron-phonon and electron-electron interactions may be unimportant for Th. Theoretical predictions are also presented for de Haas-van Alphen frequencies and cyclotron effective masses for Th. The calculated Fermi surface for Dy implies that the shape of this surface is such as to favor an antiferromagnetic superlattice. The predicted periodicity of this antiferromagnetic structure agrees with the values obtained from neutron diffraction experiments. (auth)

11689 (IS-T-111) LANDAU SPECTRUM AND LINE BROADENING IN REAL METALS. Davis, Lloyd Craig (Iowa State Univ. of Science and Technology, Ames). Nov. 1966. Contract W-7405-eng-82. 64p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The energy spectrum and level broadening of conduction electrons in the presence of a uniform magnetic field has been studied within the framework of the effective Hamiltonian formalism. A simple model which demonstrates the important ideas involved has been chosen. WKB solutions to the effective Hamiltonian have been found for this model. By using connection formulas which are accurate for all energies, it was shown how the degeneracies among the WKB solutions in different zones in reciprocal space are removed. These connection formulas were expressed in terms of a transmission amplitude p and a reflection amplitude q. It has been found that the Landau levels are given accurately by the Onsager rules and are essentially discrete except in the immediate vicinity of open orbits. The transition between the nearly discrete closed orbit region and the continuous open orbit region was found to occur in an energy range of only a few $\hbar\omega_c$. The eigenvalues and eigenfunctions of the effective Hamiltonian were shown to be consistent with the requirements of a group theoretical treatment of the exact Hamiltonian. Therefore, it has been concluded that no source of level broadening in a perfect crystal (other than interband effects) has been omitted. A justification of Pippard's linear network model for magnetic breakdown has been given within the effective Hamiltonian formalism. The effects of internal strains and dislocations on the energy levels have also been considered. (auth)

11690 (IS-T-112) POSITRON ANNIHILATION IN RARE-EARTH SINGLE CRYSTALS. Williams, Ronald Wendell (Ames

Lab., Iowa). Nov. 1966. Contract W-7405-eng-82. 87p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The angular correlation curves of positron annihilation radiation from positrons annihilating in c-axis oriented single crystals of yttrium, gadolinium, terbium, dysprosium, holmium, erbium, and holmium-50%-erbium and b-axis oriented single crystals of yttrium and holmium were measured. The curves show the highly anisotropic nature of the Fermi surface and are found to be consistent with a model recently proposed by Loucks. A connection between the occurrence of antiferromagnetism in the metals and particular features of their Fermi surfaces is suggested. Humps occur in the angular correlation curves of dysprosium, holmium, and erbium c-axis oriented single crystals at room temperature and are indicative of flat electron and hole regions of their Fermi surfaces which run parallel to one another and normal to the c axis. No humps appear in the curves of gadolinium and terbium c-axis oriented crystals at room temperature and this suggests a modification of this particular feature of the Fermi surface. Those rare-earth metals which have 4f electrons and whose curves have humps exhibit a relatively large temperature range of antiferromagnetism, while those rare-earth metals which have 4f electrons and whose curves do not have humps either have relatively small temperature regions of antiferromagnetism or no antiferromagnetism. Thus, it appears that the occurrence of parallel flat electron and hole regions of the Fermi surface running normal to the c axis are related to the ability of a metal to form a helical, magnetic structure. The angular correlation curve of the c-axis crystal of holmium at 60°K does not show a hump. This is believed to be due to the modification of the flat regions of the Fermi surface caused by the occurrence of a magnetic superlattice. The close correlation between the curves of holmium, erbium, and holmium-50%-erbium seems to indicate that the rigid band model applies and that the concept of a Fermi surface is valid for the binary rare-earth alloys with hexagonal close packed structure. (auth)

11691 (LA–3578) NUMERICAL STUDIES OF REGULAR AND MACH REFLECTION OF SHOCKS IN ALUMINUM. Mader, Charles L. (Los Alamos Scientific Lab., N. Mex.). Aug. 1966. Contract W-7405-eng-36. 39p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The regular and Mach reflections of 330 kilobar shocks in aluminum were studied using a high resolution, Lagrangian, two-dimensional, numerical hydrodynamic code of the Magee type. The numerical results compare favorably with the available experimental data. (auth)

11692 (LA–3615(Suppl.)) SUPPLEMENT TO TABLES FOR THE RAPID EVALUATION OF THE DEBYE CHARACTERISTIC TEMPERATURE OF CUBIC CRYSTALS FROM ELASTIC CONSTANTS. Overton, W. C. Jr.; Schuch, A. F. (Los Alamos Scientific Lab., N. Mex.). Dec. 22, 1966. Contract W-7405-eng-36. 27p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The main report which this work supplements is entitled "Tables for the Rapid Evaluation of the Debye Characteristic Temperature of Cubic Crystals from Elastic Constants." The range of parameters (s,τ) are extended here such that: $4.53 \leq s \leq 6.01$, $1.00 \leq \tau \leq 4.80$ and $6.03 \leq s \leq 7.51$, $1.00 \leq \tau \leq 4.80$. (M.O.W.)

11693 (N–66–33388) PHOTOVOLTAIC EFFECT AND UTILIZATION OF PHOTOVOLTAIC CELLS: EFFECT OF SUBTHRESHOLD ELECTRON RADIATION ON SURFACE PROPERTIES OF Ge P-V CELLS. Semiannual Report No. 2, November 1, 1965–May 31, 1966. Loferski, J. J.; Giriat, W.; Kasai, I. (Brown Univ., Providence, R. I. Div. of Engineering). June 1966. 32p. (NASA-CR–77042). CFSTI $3.00 cy, $0.65 mn.

The effect of high energy electron irradiation on the surface recombination properties of germanium p-n junction photovoltaic cells made by alloying appropriate impurities into wafers of various resistivities was investigated. The experiment was carried out with 250 keV electrons. It was found that the photovoltaic short circuit current had a strong dependence on integrated electron flux, on the time elapsed since the last irradiation, i.e., on the past history of the irradiated surface, on the pressure in the vessel in which the irradiation was performed, and on the resistivity of the material exposed to the electrons. For example, if the electrons were incident on the surface of 0.1 ohm cm n-Ge, the short circuit current I_s decreased by an order of magnitude after exposure to about 1200 $\mu coul/cm^2$ (7.5×09^{15} electrons/cm^2). Irradiation to higher fluxes did not lead to any additional changes, i.e., the effect had saturated. The relation between the experimentally observed changes and changes in more fundamental properties of the surface is discussed. (auth)

11694 (NP–16436) INTRODUCCION AL ESTUDIO DE LA RESONANCIA MAGNETICA. (Introduction to Magnetic Resonance). Daltabuit Godas, Enrique (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ciencias). 1966. 127p. (In Spanish). Dep. mn.

Thesis.

A textbook for an introduction to the study of magnetic resonance is presented. Magnetic resonance phenomena is first considered from the viewpoint of classical mechanics. The phenomenon is then placed within the framework of quantum mechanics. The Hamiltonian of a paramagnetic ion in a crystalline lattice and subjected to the action on an external magnetic field is described. A bibliographic appendix annotates and classifies the most important works in the area of magnetic resonance. (J.S.R.)

11695 (NYO–2150–22) SOLID STATE PHYSICS: MAGNETIC PHENOMENA. Progress Report, January 1, 1966–December 31, 1966. Bowers, R.; Silsbee, R. H. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Contract AT(30-1)-2150. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The ESR spectrum of the excited ^2E state of Cr^{3+} and V^{2+} in MgO was determined. The observation of a Stark shift of the optical zero phonon line of the R_2 band in KCl is reported. After x-irradiation of a CN^- doped crystal and annealing, two paramagnetic centers were detected and tentatively identified as HCN^- and FCN^-. The presence of a strong paraelectric resonance in KCl:Li is suggested. The spin resonance of the localized Mn magnetic moments in CuMn alloys was investigated. The magneto-resistance of K single crystals was found to increase linearly with magnetic field. Hall coefficients were determined for several metals. Studies of Helicon wave propagation in metals and of low-frequency electromagnetic phenomena in superconductors are reported. (D.L.C.)

11696 (UCRL–11813) REFLECTION OF POLARIZED LIGHT FROM ABSORBING MEDIA. Mowat, J. Richard; Muller, Rolf H. (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1966. Contract W-7405-eng-48. 108p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Reflection of polarized light from absorbing media, such as a bare metal surface in contact with a dielectric, results in characteristic changes in the polarization state from which the optical constants of the reflecting interface can be determined. Starting from Maxwell's equations of electromagnetic theory, the basic relationships of metallic reflection and exact formulas for relating the optical constants with amplitude and phase changes upon reflection are derived and illustrated by extensive numerical data. (auth)

11697 (ORNL-tr–1506) TREATMENT OF THE EXCITON BY THE MANY-ELECTRON THEORY. Haken, H.; Schottky, W. Translated for Oak Ridge National Lab., Tenn., from Z. Phys. Chem. (Frankfurt) (NF), 16: 218-44(1958). 33p. Dep. mn. JCL $3.60 fs, $1.19 mf.

After the method of determining the polarization effect of a single excess or defect electron on the bound electrons, i.e., formulating the wave function Ψ_k of these single particles in the framework of the many-particle theory, the question which of how the wave function of the exciton can be formulated from the Ψ_k is considered. (W.D.M.)

11698 NEW PHYSICAL PHENOMENON: "SHADOW EFFECT", ARISING DURING THE INTERACTION OF FAST CHARGED PARTICLES WITH MONOCRYSTALS. Tulinov, A. F. Vestn. Moskov. Univ., Ser. III: Fiz. Astron., No. 4, 119-21(July-Aug. 1966). (In Russian).

By means of the shadow effect the scattering of fast particles can be used for the study of the phonon spectra, study of the degree of perfection of the crystal, study of the structure of the crystal, and study of the character and structure layer. (J.S.R.)

11699 GRAIN-BOUNDARY RELAXATION OF MOLYBDENUM AND THE MECHANISM OF THE EMBRITTLING EFFECT OF INTERSTITIAL IMPURITY ADDITIONS. Wang, Yeh-ning; Hsu, Tsih-zan; Han, Yeh-lung (Univ. of Nanking, China). Wu Li Hsueh Pao, 22: 647-58(June 1966). (In Chinese).

The grain boundary peak in molybdenum was measured by a torsion pendulum. When the frequency of vibration is 1 cps, the peak occurs around 1020°C. This G. B. peak is reduced by oxygen or carbon additions, but an "alloy grain boundary peak" appears at the lower temperatures on the same damping curve. Using frequency of 1 cps, "oxygen peak" occurs around 890°C; and "carbon peak" occurs around 925°C. Since no peak is evident on the damping vs temperature curve of molybdenum single crystals, it may be concluded that these peaks are all associated with the stress relaxation across grain boundaries. If some carbon is also present in the sample containing oxygen, the other two "alloy grain boundary peaks" appear around 960°C and 985°C. The activation energies of all the peaks were determined. The higher is the peak temperature, the larger is the value of activation energy, i.e., the activation energy of "oxygen peak" is the smallest one

(80 kcal/mol); that of "carbon peak" is somewhat larger (98 kcal/mol); that of "pure grain boundary peak" is the largest (119 kcal/mol); and the activation energies of the other two "interaction peaks" are somewhat less than that of "pure grain boundary peak." Fractographic work was made after the damping measurements had been taken. Many black oxide spots were observed on the intergranular facets of the specimen, by which the "oxygen peak" had been measured; the feathery carbides were observed on the intergranular facets of the same specimen on which was measured the "carbon peak." When both oxygen and carbon are present in the specimen, which gives the "interaction peaks" around 960°C and 985°C, many white precipitations embedded by black rings were observed on intergranular fracture facets. Based on the results, the mechanism of the embrittlement of molybdenum by a small amount of interstitial solute elements was discussed, especially the fact that carbon counteracts the severe embrittling effect of oxygen was also explained. (auth)

11700 EFFECT OF FIELD MODULATION ON DYNAMIC NUCLEAR POLARIZATION. Ramakrishna, J. (Oxford Univ.). Phil. Mag. (8), 14: 1255-7(Dec. 1966).

The conventional theory (Jeffries 1963) indicates that the "solid state effect" method of dynamic nuclear polarization yields one enhanced and one reversed nuclear signal. Four peaks for the proton polarization in a single crystal of lanthanum magnesium nitrate containing ~1% neodymium were observed, giving two pairs of signals, each pair consisting of an enhanced signal and a reversed signal. These pairs occur on either side of the EPR line of neodymium and are very sensitive to temperature and the amount of field modulation used. (auth)

11701 EFFECT OF CERIUM ADDITION ON OPTICAL PROPERTIES OF GAMMA-IRRADIATED CaF_2:Dy^{3+} CRYSTALS. Batygov, S. Kh.; Mikaelyan, R. G.; Fursikov, M. M. (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 1533(Aug. 1966). (In Russian).

Incorporation of small quantities (0.04 wt %) of CeF_3 into CaF_2:Dy^{3+} crystals contributed to an increase in thermal and photostability of unstable Dy^{2+} which is formed by gamma irradiation of the crystals. These observations were made in a comparative study of thermal bleaching and luminescence of gamma-irradiated (10^7 rad dose) CaF_2:Dy^{3+} crystals, with and without CeF_3 addition. After two hours bleaching at 100°C, the CeF_3-containing gamma-irradiated crystals exhibited a constant coefficient of maximum absorption (at 715 mμ) which was higher than that of the similarly treated crystals without CeF_3. Also, intensity of absorption and luminescence due to Dy^{2+} increased and remained constant after a prolonged irradiation of the CeF_3-containing crystals. These increases in thermal and photostability and in the intensity of Dy^{2+} absorption bands in the presence of cerium were tentatively attributed to the formation of Ce^{4+} ions in the process of irradiation. (ATD)

11702 ROOM-TEMPERATURE LASING OF CdS UNDER PULSED-ELECTRON BOMBARDMENT. Nicoll, F. H. (RCA Labs., Princeton, N. J.). Appl. Phys. Lett., 10: 69-71(Feb. 1, 1967).

Single-crystal platelets of CdS supported on a room temperature substrate have shown laser emission under pulsed 22-kV electron bombardment at current densities around 4 A per cm^2. This threshold is not much greater than at liquid nitrogen. The green laser beam is sheet-like and has a wavelength of 5280 Å. An approximate figure for the pulsed power efficiency into the total laser beam is 0.5% at levels not far above threshold. (auth)

11703 ENERGY DEPENDENCE OF NEUTRON DAMAGE IN SILICON. Stein, H. J. (Sandia Corp., Albuquerque, N. Mex.). J. Appl. Phys., 38: 204-10(Jan. 1967). (SC-DC-66-1889).

The carrier removal produced in 10- and 100-Ω·cm, vacuum-floating-zone, n-type silicon by neutrons from a bare ^{235}U reactor was measured and compared with that produced by 14-MeV neutron irradiation of the same samples. Carrier removal rates were obtained from conductivity measurements at 283°K following irradiations at 300°K. The measured 14 MeV-to-reactor-neutron-damage ratio is 2.8 ± 0.5 for the 10-Ω·cm silicon, and 2.9 ± 0.6 for the 100-Ω·cm silicon. Very similar isochronal annealing was observed between 300 and 500°K following 14-MeV and reactor-neutron irradiation. This suggests that 14-MeV and reactor-neutron irradiation produce the same kinds of defects in n-type silicon. Total scattering cross-section data for silicon, information on nonisotropic scattering, and the Lindhard model for silicon recoil energy loss to ionization were used to calculate the average energy per cm spent in silicon displacement collisions per incident neutron between 0.2 and 14 MeV. There is general agreement between the calculated energy spent in silicon displacements as a function of neutron energy and the energy dependence of the reported monoenergetic neutron irradiation-produced carrier removal rates in n-type silicon. Dividing the predicted energy spent in collisions per neutron-cm by the carrier removal rate gives an average of 0.85 keV with a standard deviation of 0.38 keV per carrier removed for previously reported monoenergetic neutron irradiations. Using the carrier removal rates measured at 283°K for the 10-Ω·cm n-type silicon of this investigation, the average energy spent in collisions per carrier removed is 1.25 ± 0.15 keV for the reactor neutron irradiation and 0.94 ± 0.08 keV for the 14-MeV neutron irradiation. (auth)

11704 FADING IN THERMOLUMINESCENT LITHIUM FLUORIDE AFTER IRRADIATION WITH LOW DOSES. Webb, G. A. M. (Central Electricity Generating Board, Berkeley, Eng.). Brit. J. Appl. Phys., 18: 7-11(1967).

The radiothermoluminescence of LiF irradiated at low levels (0.5 rad) has been investigated. It is possible to explain the observed behavior on the basis of a simple model involving a single deep trap at 1.25 ± 0.07 eV and two or more shallower traps. The latter traps explain adequately the observed fading over a period of two months. The results do not confirm, at this level, reported anomalous fading observed at higher levels of irradiation. (auth)

11705 EVALUATION OF CdTe BY NUCLEAR PARTICLE MEASUREMENTS. Mayer, J. W. (Hughes Research Labs., Malibu, Calif.). J. Appl. Phys., 38: 296-301(Jan. 1967).

The properties of CdTe have been evaluated by investigating the pulse-height response of surface-barrier devices to monoenergetic alpha particles incident normal to the surface. The energy ϵ required to form a hole–electron pair was found to be 4.65 ± 0.2 eV. The count-rate efficiency and energy resolution that have been obtained indicate that crystals can be grown without major fluctuations in the densities of trapping or recombination centers. The effective lifetime values within the high field regions range from less than 10^{-9} sec to 4×10^{-8} sec for holes and electrons. These values represent a marked increase over the previously established value of 10^{-10} sec. (auth)

11706 METASTABLE F AGGREGATE COLOR CENTERS IN IRRADIATED KCl. McCall, Robert T.; Grossweiner, L. I. (Illinois Inst. of Tech., Chicago). Contract AT(11-1)-1052. J. Appl. Phys., 38: 284-8(Jan. 1967). (COO-1052-2).

The absorption spectra and decay lifetimes of the M center triplet state (^3M) and R center quartet state (^4R) measured in irradiated KCl are similar to previous results in additively colored crystals. The wavelength dependence of the light-induced decay indicates that the ^3M center is deactivated by illimunation in its absorption bands at 505, 590, and 685 mμ (85°K), and pumped by illumination in the M_1 band and also in the F band and K band regions. The initial yield of ^3M centers induced by pulse illumination is proportional to the M center density, both for crystals of different initial F center density bleached to maximum M band and for a crystal that was bleached through the growth and decline of the M band. The temperature dependence of the dark decay follows a configuration coordinate model in which a transition of 45-sec half-time competes with a thermally activated step of 0.064 eV activation energy. The 14-sec dark decay half-time of the ^4R center absorption at 710 mμ was found to be independent of temperature from 85 to 200°K. Possible mechanisms of metastable center formation and decay are discussed. (auth)

11707 MAGNETIC SCATTERING OF NEUTRONS BY MnF_2 CLOSE TO THE NEEL POINT. Antonini, M. (CEN, Saclay, Gif-sur-Yvette, France). J. Phys. Chem. Solids, 28: 11-16 (Jan. 1967). (In French).

The differential cross section of inelastic scattering of slow neutrons by MnF_2 was measured close to the Néel temperature, using a "time of flight" method. The angular distribution and the energy spectrum of the scattered neutrons were observed for different values of the angle of rotation of the crystal, aligned in the neighborhood of the Bragg magnetic peak position (100). At ($T - T_N = 0.92$°K, a value of 17 Å was found for the spatial correlation parameter $1/K_1$ of the critical fluctuations of magnetization; this is in good agreement with theoretical prediction, and the results of previous experiments. However, the information derived from the energy spectra does not appear to confirm the theory of spin relaxation in an antiferromagnetic body. The limits of applicability of this theory are discussed, and this leads to an expression for the differential cross section taking into account the experimental resolution. This expression is compared with the results of the experiment. (auth)

11708 MAGNETIC RESONANCE OF SMALL PARTICLES OF LITHIUM. Taupin, Christiane (CNRS, Orsay, France). J. Phys. Chem. Solids, 28: 41-8(Jan. 1967). (In French).

X-ray diffraction studies have shown that, in heavily neutron-irradiated LiF crystals, very small metallic particles are formed. These particles, of an exceptionally high degree of purity, assume

a great variety of shapes and dimensions. With a simple theoretical model, many characteristic effects can be predicted regarding the magnetic resonances of some of these particles: a narrow Knight-shift-less NMR spectrum, a Curie-type paramagnetism, and extremely narrow EPR lines. All these effects have been verified by carefully comparing the structure of the samples as given by x-ray diagrams and the EPR and NMR spectra. Moreover, electronic paramagnetic relaxation inside very pure metallic particles was found to be caused by a surface mechanism different from the mechanism proposed in previous works. (auth)

11709 THE DEPENDENCE OF COLORING YIELD ON THE ELECTRON BEAM ANGLE OF INCIDENCE FOR NaCl CRYSTALS. Agarbiceanu, I.; Teodorescu, I.; Teodorescu, G. (Polytechnic Inst., Bucharest). Rev. Roum. Phys., 11: 527-41(1966).

Sodium chloride crystals were irradiated with electrons of energy 33.5 to 60 keV, and current densities of 25 to 150 $\mu amp/cm^2$, for incidence angles of 0, 30, 45, and 60°. The results of color center formation are summarized. (M.O.W.)

11710 DEPENDENCE OF CHARGE CARRIER MOBILITY ON TEMPERATURE IN GaAs CRYSTALS IRRADIATED WITH FAST ELECTRONS. Vavilov, V. S.; Plotnikov, A. F.; Selezneva, M. A.; Sokolova, A. A. (Lebedev Inst. of Physics, Moscow). Fiz. Tverd. Tela, 8: 3390-1(1966). (In Russian).

An investigation was made of the effect of radiation defects in the crystal structure of GaAs on the scattering character of the charge carriers at different temperatures. Four pure specimens, in which the mobility of charge carriers at temperatures from 100 to 300 K was due mainly to the scattering on optical lattice vibrations, were irradiated with a gradually increasing flux of electrons with an energy of about 1 MeV at room temperature. In pure GaAs crystals at temperatures higher than 300 K, the mobility is due primarily to the scattering on polar optical lattice vibrations. At temperatures lower than 100 K, scattering on ionized impurities prevails. In the temperature range from 100 to 300 K, both types of scattering take place, although with an increase in impurity concentration the scattering on ionized impurities becomes more substantial. In irradiated crystals the mobility was due to scattering of charge carriers on simple point defects. The calculated number of displaced atoms due to irradiation coincided with the number of scattering centers determined experimentally. This proves that structure defects affecting the scattering character in GaAs crystals irradiated with electrons are really Frenkel defects. (ATD)

11711 SCATTERING OF MOESSBAUER LINES BY CRYSTALS. Kuzmin, R. N.; Kolpakov, A. V.; Zhdanov, G. S. (Moscow State Univ.). Soviet Phys.-Cryst. (Engl. Transl.), 11: 457-62(Jan.-Feb. 1967).

Translated from Kristallografiya, 11: 511-19(July-Aug. 1966).

A theory is presented for the application of the Moessbauer effect to the study of atomic structure in crystals. A possible practical scheme of operation is presented. The prospects of the method are discussed in the light of the latest experimental evidence. (auth)

11712 EFFECT OF DIFFERENT LATTICE DEFECTS ON THE MOBILITY OF DISLOCATIONS IN ALKALI HALIDE CRYSTALS. Boyarskaya, Yu. S.; Zhitaru, R. P.; Koloskova, V. G. (Inst. of Applied Physics, Kishinev). Phys. Status Solidi, 19: 441-51(Jan. 1, 1967).

Single crystals of KCl and NaCl are subjected to additive coloration treatment and x irradiation, and their hardening and softening are observed. It is found that F centers and colloids have no appreciable effect on the mobility of dislocations. The assumption is made that certain defects are responsible for the hardening of irradiated NaCl crystals. These defects are due to soft irradiation and it is possible that they may be concerned with the generation of new vacancies during the irradiation. (auth)

11713 RELAXATION NARROWING AND THERMAL SHIFT OF MOESSBAUER LINES. Nussbaum, R. H. (Portland State Coll., Oreg.); Dash, J. G. Phys. Status Solidi, 19: K31-4(Jan. 1, 1967).

The modulation of the zero-phonon gamma emission rate in Moessbauer experiments due to the relaxation of the highly excited vibrational mode during the nuclear lifetime is calculated. The temperature-dependent relativistic frequency shift accompanying the cooling of the hot localized mode is included within the framework of the semiclassical theory. Machine calculations of the resonance line shapes for given parameters were made. The results indicated a line narrowing that has not been observed in experiments. Possible reasons for the discrepancy are considered. (A.G.W.)

11714 ELECTRONMICROSCOPY OF SMALL DEFECT AGGLOMERATES IN IRRADIATED METALS. I. THEORY OF CONTRASTS AND EXPERIMENTAL METHOD FOR DETERMINING TYPES OF DEFECTS. Ruehle, M. (Max-Planck-Institut fuer Metallforschung, Stuttgart. Technische Hochschule, Stuttgart). Phys. Status Solidi, 19: 263-78(Jan. 1, 1967). (In German).

Irradiation of metals with particles produces defect clusters visible in the electron microscope. The structure of the defect clusters cannot, however, be deduced from the contrast, if the defects are smaller than 150 Å. A comparison between specifically designed experiments (dynamical two-beam approximation) and the results of the theory of contrast does, nevertheless, permit the determination of the defect type (i.e., the simplest possible shape of the defects and the distinction between vacancy and interstitial agglomerates). This analysis is applied to the defects visible in neutron-irradiated copper. It is shown that almost all of the investigated defects may be interpreted (in the simplest case) as Frank dislocation loops of the vacancy type. (auth)

11715 ELECTRONMICROSCOPY OF SMALL DEFECT AGGLOMERATES IN IRRADIATED METALS. II. INVESTIGATIONS ON NEUTRON- AND ION-IRRADIATED COPPER AND ON NEUTRON-IRRADIATED NICKEL. Ruehle, M. (Max-Planck-Institut fuer Metallforschung, Stuttgart. Technische Hochschule, Stuttgart). Phys. Status Solidi, 19: 279-95(Jan. 1, 1967). (In German).

A study is made of the defects observed in copper after neutron and ion bombardment, and in nickel after neutron irradiation. The true size and the size distribution of the agglomerates may be determined from a quantitative comparison between the contrast width known from theory of contrast and the observed defect sizes. An analysis of the defect type revealed that all the visible defects in copper after neutron or ion bombardment (using an electron microscope with 100 kV- and 40 kV-ions) were formed by the condensation of vacancies. The same results are obtained for the defects observed in neutron-irradiated nickel. The interstitials generated during irradiation must therefore have either annealed out at sinks (grain boundaries, dislocations, vacancies) or agglomerated to defects beyond the present limit of resolution of the electron microscope. A quantitative comparison between the observed defect concentration and the energy distribution of the primary recoil atoms shows that all primary recoil atoms with energies greater than (30 ± 10) keV generate a defect visible in the electron microscope. (auth)

11716 NUCLEAR MAGNETIC RESONANCE AND MOESSBAUER EFFECT STUDY OF ^{119}Sn IN RARE EARTH–TIN INTERMETALLIC COMPOUNDS. Borsa, F. (Univ., Pavia, Italy. Ames Lab., Iowa); Barnes, R. G.; Reese, R. A. Phys. Status Solidi, 19: 359-71(Jan. 1, 1967). (IS–1460).

The nuclear magnetic resonance and Moessbauer effect of ^{119}Sn have been studied in the cubic intermetallic compounds RSn_3 (R = La, Ce, Pr, Nd, Sm, and Yb). Both the isotropic and anisotropic components of the Knight shift were determined in the temperature range 77 to 400°K. In the cases of $PrSn_3$ and $NdSn_3$ in which the shift measurements are proportional to the magnetic susceptibility, the results may be understood in terms of the Ruderman–Kittel–Kasuya–Yosida theory, with an exchange interaction, $\Gamma = -0.2$ eV. The cases of $CeSn_3$ and $SmSn_3$ do not appear to be interpretable in terms of the RKKY theory. For $PrSn_3$, $NdSn_3$, and $SmSn_3$ the Moessbauer effect of the ^{119}Sn yielded a resolved quadrupole splitting of approximately 1.1 mm/sec, independent of temperature in the range 4.2 to 300°K. The isomer shift was +0.70 mm/sec, relative to Mg_2Sn, also independent of temperature. The measured quadrupole coupling has been compared with that expected on the basis of the ionic model. No magnetic splitting was ever unambiguously observed, even at 1.5°K. Assuming that the magnetic splitting remains masked by the quadrupole interaction leads to an estimate of $H_{eff} \leq 9 \times 10^3$ Oe in $PrSn_3$ and $NdSn_3$. (auth)

11717 TEMPERATURE DEPENDENCE OF RADIOLUMINESCENCE YIELD IN ALKALI HALIDE CRYSTAL PHOSPHORS. Aluker, E. D.; Mezina, I. P. (Inst. of Physics, Riga). Phys. Status Solidi, 19: 35-40(Jan. 1, 1967).

Emission spectra, thermal luminescence, and temperature dependence of luminescence yield of thallium- and indium-activated alkali halide phosphors are measured in the temperature range 80 to 600°K. The decrease of luminescence yield at low temperatures is explained as being due to localization of electrons at activator centers. (auth)

11718 DISORDER RESISTIVITY AND SPIN DEPOLARIZATION IN RARE EARTH ALLOYS. van de Braak, H. P.; Caspers, W. J. (Univ. of Groningen, Netherlands). Phys. Status Solidi, 19: 385-93(Jan. 1, 1967).

Comparison of experimental results with the theory of the electrical resistivity of ferromagnetic rare earth alloys suggests a

rapid redistribution of the scattered conduction electrons over the two spin orientations. In order to investigate whether this effect might be due to the Coulomb interaction between the conduction electrons, the mean free path for depolarization is calculated. In the Born approximation, the mean free path is of the order of some centimeters, whereas the mean free path for scattering is about 50 Å. (auth)

11719 LINE PROFILES OF NEUTRON POWDER-DIFFRACTION PEAKS FOR STRUCTURE REFINEMENT. Rietveld, H. M. (Reactor Centrum Nederland, Petten). Acta Crystallogr., 22: 151(1967).

A structure refinement procedure is described, which obtains a least-squares fit between the calculated and observed intensities measured at equal angular intervals on a neutron powder diffractometer. It is shown that the structure parameters are significantly more reliable than those determined by a method using the integrated intensities of overlapping peaks. (auth)

Theoretical Physics

Refer also to abstract 11368.

11720 (ISS-66-27) INTRODUZIONE ALLA FISICA DELLE RADIAZIONI. CAPITOLO IV. (Introduction to Radiation Physics. Chapter IV). Amaldi, U. Jr. (Istituto Superiore di Sanita Rome (Italy). Laboratori di Fisica). July 28, 1966. 77p. (In Italian). Dep. mn.

This issue is devoted to a short presentation of the classical laws of the electromagnetic field; particular attention is paid to the propagation of energy in free space through electromagnetic waves and to their production and absorption. In parallel the granular structure of matter is discussed together with the fundamental properties of atoms (dimensions, charge, and mass). Finally the classical distinction between corpuscular and wave radiations is introduced and the classification of known radiations from the point of view of classical physics is given. (auth)

11721 (N-66-19765) RIGID MOTIONS IN EINSTEIN SPACES. Wahlquist, Hugo D.; Estabrook, Frank B. (Jet Propulsion Lab., Pasadena, Calif.). Mar. 15, 1966. Contract NAS7-100. 42p. (NASA-CR-71283; JPL-TR-32-868). CFSTI $3.00 cy, $0.65 mn.

The dyadic formulation of general relativity is used systematically to discuss rigid congruences in Einstein space-time. For space-time of uniform curvature, the quotient space metrics of rotating and accelerating rigid bodies are obtained. For Einstein space-time of nonuniform curvature, all irrational, nonisometric, rigid motions are explictly displayed. They have one degree of freedom, and occur only in degenerate static metrics of Class B. Rotating rigid congruences in Einstein space-time of nonuniform curvature are shown to have no degrees of freedom. Their evolution is, in fact, found to be governed by a complete set of 14 first-order total differential equations, linear in the time derivatives of the dyadic variables. Such rotating motions are shown further to be constrained by a set of algebraic conditions; the implication of this for the validity of the Herglotz-Noether theorem in Einstein space-time is discussed. (auth)

11722 (N-66-20036) PRINCIPLES OF GENERAL COVARIANCE IN ITS VARIOUS FORMULATIONS AND THE RELATED PROBLEMS OF THE ROLE OF COORDINATES IN GENERAL RELATIVITY. Final Report. Anderson, James L. (Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics). June 1965. 41p. (NASA-CR-70941; SIT-P-149(6165)). CFSTI $3.00 cy, $0.65 mn.

The general problem of how large a set of covariance conditions can be imposed on a theory with a covariance group is discussed. In imposing such conditions the natural requirement is made that such conditions must be satisfiable by at least one member of every equivalence class of physically distinct solutions. Even so it is shown in the cases of electrodynamics and relativity theory that a number of conditions can be imposed sufficient to reduce the covariance group down to the identity. As a consequence it is concluded that the Kretschman definition of the relativity group of a theory is not a useful definition since it always leads to the relativity group being the identity group. (auth)

11723 INVESTIGATION OF THE SIGN OF THE ENERGY OF HORIZONTAL GRAVITATIONAL WAVES. Khiet, Vu Thanh. Vestn. Moskov. Univ., Ser. III: Fiz. Astron., No. 4, 20-6(July-Aug. 1966). (In Russian).

The energy of some horizontal gravitational waves were calculated from the results of the concept of comparative gravitational fields. It is explained that the sign and value of the energy depends on the energy of the supporting point and on the structure of the wave. It is shown that the local energy of region II of the comparative support point in this region is positive for the type of wave examined. (tr-auth)

11724 INDUCED EFFECT DURING GRAVITATIONAL AND POSSIBLE GRAVIMAGNETIC INTERACTION. Slabkii, L. I. Vestn. Moskov. Univ., Ser. III: Fiz. Astron., No. 4, 47-51(July-Aug. 1966). (In Russian).

The induced gravitational effects are described and two variants for their experimental verification are proposed. (tr-auth)

11725 PROPAGATION OF WAVES IN RANDOM MEDIA AND STOCHASTIC EQUATIONS. PART I. Frisch, U. (Institut d'Astrophysique, Paris). Ann. Astrophys., 29: 645-82(Nov.-Dec. 1966). (In French).

Part I is concerned with some fundamental problems arising in the study of wave propagation in random media and more generally of linear differential, partial differential, and integral equations with random coefficients. Differential equations with Markov coefficients are shown to be reducible to the solution of linear partial differential nonrandom equations, and some partial differential equations with Gaussian coefficients (among which the scalar wave equation) are shown to be reducible to the evaluation of Wiener functional integrals. A rather general perturbation method called the method of smoothing is developed, which applies to the calculation of approximate solutions of many linear (random or nonrandom) equations of mathematical physics. In part II these methods will be applied to several problems of physical and astrophysical interest. (auth)

11726 SELF-GRAVITATIONAL RAYLEIGH-TAYLOR INSTABILITY. Occhionero, F. (Laboratoire d'Astrophysique, Rome). Ann. Astrophys., 29: 549-63(Nov.-Dec. 1966).

The Rayleigh-Taylor instability is studied in the presence of self-gravitational fields. It is found that these fields substantially enhance the instabilities in the long wave-length side of the perturbation spectrum. Thus, if for some mechanism of surface tensions, these are the only perturbations which matter for the instability, self-gravitation is to be taken carefully into account in the astrophysical structures where such phenomena occur. (auth)

11727 NEW METHOD OF EXPANSION IN THE QUANTUM MANY-BODY PROBLEM. Edwards, S. F.; Sherrington, D. (Univ. of Manchester, Eng.). Proc. Phys. Soc. (London), 90: 3-22(Jan. 1967).

A new method of expansion for the Green functions of the quantum many-body problem is given. The Feynman representation of quantum mechanics is used and the basic factor $\exp\{(i/\hbar)\int L\, d^3x\, dt\}$, where L is the Lagrangian density, is expanded in Hermite functionals. This leads to an equation for the single-particle Green function which has strong connections with the usual Boltzmann equation, and the solutions of which automatically satisfy sum rules. The quasi-particle concept appears very clearly, with its limitations also clarified, and the derivation of the Boltzmann equation is greatly simplified. (auth)

11728 THE MOTION OF A FALLING PARTICLE IN A SCHWARZSCHILD FIELD. Rao, K. N. Srinivasa (Univ. of Mysore, India). Ann. Inst. Henri Poincare, Sect. A, 5: 227-33 (1966).

It is shown that the rectilinear motion of a particle in a Schwarzschild field reduces to the Newtonian law in the limit $S \to 0$ where $S = 2GM/c^2$ is the Schwarzschild radius and that it reduces to a motion according to Special Relativity in a differential region if S^2 is neglected, thus illustrating Einstein's Principle of Equivalence. Relativistic analogues of the Galilean laws for a falling body are incidentally obtained. (auth)

11729 SPINOR FORMALISM IN GRAVITATION. Oliveira, C. G.; Marcio do Amaral, C. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Nuovo Cimento (10), 47A: 9-18(Jan. 1, 1967).

The relations between two well known spinor approaches to the theory of general relativity, namely the approach of Witten and Penrose, and the approach of van der Waerden and Infeld, also treated more recently by Bergmann are derived. It has been shown that both theories are related by means of rather simple equations. The two cases of spaces filled with matter and empty spaces are treated in some detail. The relations presently given, are of technical interest if one tries to work out the quantization of the gravitational field in the framework of Witten's formalism. This can be done in principle by means of the quantization of Bergmann's formalism in the Hamiltonian method. The classical Hamiltonian formulation of general relativity for the case of this latter theory is already known. (auth)

11730 COSMOLOGICAL SOLUTIONS OF LINEAR FIELD THEORY. Scherrer, Willy. Z. Astrophys., 65: 30-44(1967). (In German).

The most general characteristic function of linear field theory

which does not restrict the Lorentz group is a linear function of the three fundamental invariants H_1, H_2, H_3:

$$W = \Lambda_0 + \Lambda H_{11} + \Lambda H_{22} + \Lambda H_{33}.$$

To each such characteristic function there belong cosmological solutions. These solutions are all determined. Each model of a universe resulting that way is represented by a hypersurface of 2nd degree in affine 5-space. Of special interest are the "main solutions", i.e., those models which are represented by hypersurfaces symmetrical with respect to the origin: they admit a 10-parameter group of automorphisms, while for all the remaining solutions the rank of the automorphism group is less than 10. The main solutions belong to three subclasses: 1. monotonic solutions of 2nd kind (de Sitter universe). 2. monotonic solutions of 1st kind (universe with catastrophical beginning). 3. periodical solutions. In addition to these solutions formulas for the corresponding red shift are developed. (auth)

11731 QUANTUM MECHANICS, VOLUME II. NEW QUANTUM THEORY. Tomonaga, Sin-itiro. New York, John Wiley and Sons, Inc., 1966. 484p. $15.50.

The various chapters discuss (1) the wave theory of matter, (2) the Schroedinger equation, (3) the physical interpretation of the Schroedinger equation, (4) quantum-mechanical states, (5) many-particle systems and wave fields, and (6) angular momentum and spin. (M.O.W.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Electromagnetic

11732 DATA ON PARTICLES AND RESONANT STATES. Rosenfeld, Arthur H. (Univ. of California, Berkeley); Barbaro-Galtieri, Angela; Podolsky, William J.; Price, Leroy R.; Soding, Paul; Wohl, Charles G.; Roos, Matts; Willis, William J. Rev. Mod. Phys., 39: 1-51(Jan. 1967).

Data on the properties of leptons, mesons, and baryons are listed, referenced, averaged, and summarized in tables and wallet cards. This is an updating of the Reviews of Modern Physics article of October 1965. (auth)

Weak

Refer also to abstract 11732.

11733 ENERGY SPECTRA AND ANGULAR CORRELATIONS OF K_{e3} DECAY PARTICLES. Kulyukina, L. A.; Mestvirishvili, A. N.; Neagu, D.; Petrov, N. I.; Rusakov, V. A.; Tsun-fan, U. Zh. Eksp. Teor. Fiz., 52: 90-6(Jan. 1967). (In Russian).

The energy spectra and electron and π meson emission angle distributions based on 394 K_{e3} decay events are presented for those cases when the π meson energy lies between 231 and 270 MeV. The distributions can be satisfactorily described only by the vector interaction theory. With a certainty of more than 99.9% the scalar and tensor theories can be rejected as the only type of interaction. Their possible contribution to the interaction is 10 to 12%. No dependence of the form factor g_V on electron energy is detected experimentally. (auth)

11734 DETERMINATION OF THE PHASE OF THE CP-NON-CONSERVATION PARAMETER η_+ IN NEUTRAL K DECAY. Mischke, R. E.; Abashian, A.; Abrams, R. J.; Carpenter, D. W.; Nefkens, B. M. K.; Smith, J. H.; Thatcher, R. C.; Verhey, L. J.; Wattenberg, A. (Univ. of Illinois, Urbana). Phys. Rev. Lett., 18: 138-42(Jan. 23, 1967).

The phase of η_+ was determined by measuring the phase between $K_L^0 \rightarrow \pi^+ + \pi^-$ and regenerated $K_S^0 \rightarrow \pi^+ + \pi^-$ and by evaluating the regeneration phase by means of an optical-model calculation. The experiment is described and the results are analyzed. The results are found to agree with most models of CP nonconservation which predict $\arg\eta_+ \approx \arctan(2\Delta m/\Gamma_S) \approx 45°$. (L.B.S.)

Strong (Baryon-Induced)

Refer also to abstract 11732.

11735 (IS-T-127) DOUBLE PION PRODUCTION WITHOUT ANNIHILATION IN ANTIPROTON–PROTON INTERACTIONS AT 2.7 GeV/c. Crawley, Henry Bert (Ames Lab., Iowa). Nov. 1966. Contract W-7405-eng-42. 64p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

A study was made of the reaction $\bar{p}p \rightarrow \bar{p}p\,\pi^+\pi^-$ at an incident antiproton momentum of 2.7 BeV/c. The total cross section for this reaction was determined to be 1.93 ± 0.16 mb. The data were found to be consistent with 100% $N^*\bar{N}^*$ formation where N^* is the pion-nucleon resonance with $T = T_z = J = 3/2$, central mass value 1238 MeV, and width 125 MeV. It was observed that the $\bar{N}^*$ production is highly peripheral; that is, in the over-all center of mass system more than 50% of the $\bar{N}^*$'s are produced with a production angle whose cosine is greater than 0.8. A comparison of the data with the predictions of the form-factor and absorption one-pion-exchange models was made. For the form-factor model only the contribution from the double-isobar diagram was included, as modified by the form-factor and off-shell corrections given by Selleri. The $T_z = 1/2$ diagram was excluded because it is predicted to contribute only 1% of that of the double-isobar diagram. Finally, the contribution from the Drell diagrams was excluded on empirical grounds, since the Drell diagrams contribute to zero or single resonance production, and the data are consistent with 100% double resonance formation. For the absorption model the predictions supplied by Hite and Jackson were compared with the data. It is found that both models account for the peripherality of the $\bar{N}^*$ production and for the effective mass distribution, but that neither model is successful in explaining the decay angular distributions. (auth)

11736 AN INVESTIGATION OF COSMIC RAYS UNDERGROUND USING A SCINTILLATOR STACK. IV. AN UPPER LIMIT FOR THE RATE OF RELATIVISTIC PARTICLES OF CHARGE TWO-THIRDS. Barton, J. C. (Northern Polytechnic, London). Proc. Phys. Soc. (London), 90: 87-90(Jan. 1967).

The stack was operated for two months under conditions such that it was sensitive to particles of charge $\frac{2}{3}$ e. At a depth of 60 mwe the rate of such particles was not greater than 0.005 m^{-2} $sterad^{-1}$ h^{-1}. (auth)

11737 EXPERIMENTAL SEARCH FOR FRACTIONAL CHARGES. Braginskii, V. B.; Zeldovich, Ya. B.; Martyunov, V. K.; Migulin, V. V. Zh. Eksp. Teor. Fiz., 52: 29-39(Jan. 1967). (In Russian).

A method is developed for determining the electric charge of small bodies. The accuracy of the method is of the order of 0.1 e for body masses of the order of $(0.3-2.0)\ (10^{-8})$ g. The Braunbeck method for restraining a diamagnetic body by a stationary magnetic field as modified by Becchi, Galinarro and Morpurgo for the given purpose is employed. The results of two sets of experiments are described. In some of the experiments effects were observed which may be attributed to fractional charges. Possible disturbing effects which may imitate those due to fractional charges are considered. Because of these disturbing effects it cannot be affirmed that under the experimental conditions fractional charges were observed. Requisite improvements of the method are discussed. (auth)

11738 EVALUATIONS OF MASS OF TARGET ISOBAR AND FOUR-MOMENTUM TRANSFER IN COSMIC-RAY JETS. Kazuno, M. (Dublin Inst. for Advanced Studies). Nuovo Cimento (10), 47A: 73-84(Jan. 1, 1967).

Direct quantitative evaluations of four-momentum transfer, inelasticity and mass of target isobars in cosmic-ray jets have been carried out with the information of target particles. Average value of four-momentum transfer to target particles Δ_N is found to be ~ 0.7 GeV for the jets with $\langle\gamma_c\rangle = 18.5$. Occurrence of jets with small four-momentum transfer ($\Delta_N \leq 1$ GeV) is found to be ~ 0.5 for the primary energy region of 10^{11} to 10^{13} eV and ~ 0.6 for that of 10^{13} to 10^{14} eV. Slight tendency to correlation between Δ_N and n_s is seen although Δ_N is evaluated independently of n_s. Target isobars so far investigated are dominated by the resonance of isotopic spin $I = 3/2$. When one takes into account the formation of target isobars, the value of four-momentum transfer Δ_N increases slightly. (auth)

Strong (Meson-Induced)

Refer also to abstract 11732.

11739 (NYO-2171-219) BACKWARD π p SCATTERING. Selove, W. (Pennsylvania Univ., Philadelphia). Aug. 1966. Contract AT(30-1)-2171. 28p. (CONF-660420-3). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Conference on Two-Body Problems at High Energy, Stony Brook, N. Y.

Measurement of the differential cross section is reported for elastic scattering of positive and negative π mesons from hydrogen at 4 to 8 GeV/c, around 180° c.m.s., corresponding to a range of U (square of the four-momentum transfer from incoming pion to outgoing proton) from 0.1 to -1.0 $(GeV/c)^2$. (B.G.D.)

11740 EVIDENCE FOR VECTOR MESON EXCHANGE IN ρ^- PRODUCTION AT 8 GeV/c. Derado, I.; Poirier, J. A.; Biswas, N. N.; Cason, N. M.; Kenney, V. P.; Shephard, W. D. (Univ. of Notre Dame, Ind.). Phys. Lett., 24B: 112-14(Jan. 23, 1967).

ρ^- production was studied at 8 GeV/c. The data cannot be explained by one-pion-exchange with absorption and it is concluded that vector exchange contributes. This contrasts with ρ^0 production at this energy and ρ^- production at lower energy. (auth)

11741 POLARIZATION AND ANGULAR DISTRIBUTION OF THE Λ^0 IN ASSOCIATED PRODUCTION. Auerbach, L. B.; Bowen, D.; Dobbs, J.; Lande, K.; Mann, A. K.; Sciulli, F. J.; Huto, H.; White, D. H.; Young, K. K. (Univ. of Pennsylvania, Philadelphia). Nuovo Cimento (10), 47A: 19-34(Jan. 1, 1967).

In an experiment performed at the BNL Cosmotron, an array of spark-chambers and scintillation counters were used to study the angular distribution and polarization of the Λ^0 produced in the reaction $\pi^- + p \rightarrow \Lambda^0 + K^0$. The data were analyzed to provide dis-

tributions in $d\sigma/d\Omega_\Lambda^{cm}$ and $\alpha P_\Lambda(\theta_\Lambda^{cm})$ in six intervals (ΔP_π = 25 MeV) of incident pion momentum from 900 to 1050 MeV/c. For each ΔP_π, a value of αP_Λ, summed over angle, is presented. From a sample of 585 events in which both K^0 and Λ^0 were detected, and for which the Λ^0 proper-times extended from $1.5\tau_\Lambda$ to $6\tau_\Lambda$, a value $\tau_\Lambda = (2.68^{+0.13}_{-0.11}) \cdot 10^{-10}$ s was obtained for the Λ^0 mean life. (auth)

11742 OBSERVATION OF THE HEAVY NUCLEON ISOBAR N_η^* (3690). Bartke, J. (Inst. of Nuclear Research, Krakow); Czyzewski, O.; Danysz, J. A.; (and others). Phys. Lett., 24B: 118-20(Jan. 23, 1967).

The analysis of the eight-prong interactions of 8 GeV/c π^+ with protons indicates the existence of the new heavy nucleon isobar with the mass M = 3.69 GeV and the isospin T = ½. (auth)

11743 THE PRODUCTION OF ELECTRON PAIRS OF HIGH INVARIANT MASS IN 830 MeV/c (π^+-NUCLEUS) INTERACTIONS. Esten, M. J. (London Univ.); Govan, M.; Knight, W. L.; Miller, D. J.; Tovey, S.; Bowler, M. G.; Cashmore, R. J.; Perkins, D. H.; Waldron, O. C. Phys. Lett., 24B: 115-17(Jan. 23, 1967).

Nine electron pairs of invariant masses in the range 350 to 650 MeV/c^2 were observed in 1.75×10^6 interactions of 830 MeV/c positive pions in freon CF_3Br. The observed cross section is compatible with the process of inverse pion electroproduction, via intermediate vector mesons. (auth)

Particle Interactions and Properties (Theoretical)

Refer also to abstract 12027.

General

11744 RELATIVISTIC THEORY OF ANGULAR CORRELATIONS AND A PHENOMENOLOGICAL ANALYSIS OF PARTICLES AND RESONANCES. de Rafael, Eduardo (Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France). Ann. Inst. Henri Poincare, Sect. A, 5: 83-204(1966). (In French).

The general principles of relativistic invariance are applied to problems on angular correlations in high energy physics. Some fundamental results of relativistic kinematics and the properties of the spin density matrix for particles of arbitrary spin are recalled. The connection between the covariant formalism and the multipole parametrisation is also discussed. The description of the relativistic kinematics of vertex functions is discussed, and the selection rules are given. The expansion in terms of relativistic invariant functions (multipole form factors) is studied. The phenomenological description of two-body decay processes is considered, and the corresponding study for the three-body decay processes is made. Some technical details are given. The interest of the formalism developed is illustrated with several applications. Original applications are given: to the spin determination of the A_2 (1324) resonance; and to the spin parity determination of the strange baryon resonances. (auth)

11745 NONNEGATIVITY OF SPIN DENSITY MATRIX. Marinov, M. S. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 4: 1251-4(Dec. 1966). (In Russian).

The inequalities satisfied by polarization moments are found. These inequalities have an invariant form and are necessary and sufficient for the density matrix to have no negative eigenvalues. (auth)

11746 SECHENIYA VZAIMODEISTVIYA ELEMENTARNYKH CHASTITS. (Cross Sections of Elementary Particle Interactions). Barashenkov, V. S. Moscow, Izdatel'stvo Nauka, 1966. 532p.

Theoretical and experimental data are presented on the cross sections of interacting elementary particles. The total cross sections of elastic and inelastic interactions; resonance interactions and their analysis; and data on energies exceeding 30 GeV, obtained for cosmic ray interactions with nuclei, are analyzed. Practical graphs with interpolated cross section magnitudes are included. Theoretical interpretation of the experimental data and general properties of elementary particles are discussed as well as certain problems in the interactions of fast particles with nuclei which are important for determining cross sections of the interactions of these particles. (R.V.J.)

Electromagnetic

Refer also to abstracts 11763, 11777, and 12115.

11747 (JINR-P2-3073) ELEKTRICHESKAYA I MAGNITNAYA POLYARIZUEMOSTI MEZANOV I BARIONOV V MODELI KVARKOV. (Electromagnetic Meson-Baryon Polarizability in Quark Model). Zaikov, R. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 9p. (In Russian). Dep. mn.

The relations between the coefficients of electric and magnetic polarizabilities of the mesons and baryons are obtained on the basis of nonrelativistic quark model. Some theoretical numerical estimates are given for the magnetic polarizabilities. (auth)

11748 INSTRUMENTATION FOR STUDYING π^+-MESON PHOTOPRODUCTION. Aleksandrov, Yu. M.; Grushin, V. F.; Zapevalov, V. A.; Leikin, E. M. Tr. Fiz. Inst., Akad. Nauk SSSR, 34: 213-19(1966). (In Russian).

In investigating the reaction $\gamma + p \rightarrow \pi^+ + n$ with 230 MeV gamma quanta, there is a kinematic relation between the energy of the gamma quantum and the angle of emission of the π-meson. The problem can be resolved by counting only the π^+-mesons emitted at a given angle with a definite energy. A scintillation counter with a small inlet aperture can be used for counting the π^+-mesons. Magnetic analysis and measuring the range in a substance can be used to determine the energy of the π^+-mesons. The π^+-mesons can also be identified from the $\pi \rightarrow \mu$-transition, which takes place with a characteristic time $\tau_\pi = 2.55 \times 10^{-8}$ sec. The pulse from the π^+ meson and the pulse from the μ^+ meson are counted in coincidence to detect the π^+ mesons. About 10^5 positrons per π^+ meson are present as background after passing the beam through a magnet. An anticoincidence scheme eliminated most of the positron interference because of the difference in ranges of the positrons and π^+ mesons. A triple coincidence scheme was used to detect the $\pi^+ \rightarrow \mu$-decay. A diagram of the electronic arrangement is presented. The lifetime of the π^+ meson was determined from a plot of N_μ as a function of the time shift in the gate pulse. (TTT)

11749 SUPPRESSION OF THE φ PHOTOPRODUCTION IN THE QUARK MODEL. Kajantie, K.; Trefil, J. S. (CERN, Geneva). Phys. Lett., 24B: 106-7(Jan. 23, 1967).

The ratio of the total photoproduction cross sections $\sigma_\varphi/\sigma_\rho$ is calculated in the quark model. Good agreement is found with recent experimental data. (auth)

11750 A REMARK ON THE PHOTOPRODUCTION OF VECTOR MESONS. Joos, H. (DESY, Hamburg). Phys. Lett., 24B: 103-5(Jan. 23, 1967).

The cross sections for photoproduction of vector mesons are calculated combining photo-dissociation model and quark model. (auth)

11751 PROTON COMPTON SCATTERING AT 600 TO 750 MeV. Minami, S. (Osaka City Univ.). Nuovo Cimento (10), 47A: 64-72(Jan. 1, 1967).

Proton Compton scattering at 600 to 750 MeV is described in terms of the effects of possible resonances S_{11} and P_{11} in addition to those of the well-established $P_{33}(1238)$ and $D_{13}(1518)$. The main results are the following: (1) The angular distribution for γ-p elastic scattering becomes larger in the forward than in the backward direction as the incident energy increases. (2) $d\sigma/d\Omega(90°)$ around 740 MeV can be described fairly well by the effect of the $D_{13}(1518)$. In scattering at 600 to 675 MeV, on the other hand, contributions from the $D_{13}(1518)$ to $d\sigma/d\Omega(90°)$ are nearly equal to those from the other resonant states. (3) Polarization measurements on proton Compton scattering at 700 to 740 MeV can give us important information concerning both the existence of the $P_{11}(1480)$ and the properties of the S_{11} resonance. (auth)

11752 THEORETICAL CALCULATIONS FOR ELECTRON–POSITRON COLLIDING-BEAM REACTIONS. Altarelli, G. (Univ., Florence); De Gennaro, S.; Celeghini, E.; Longhi, G.; Gatto, R. Nuovo Cimento (10), 47A: 113-35(Jan. 1, 1967).

The radiative corrections to a typical colliding-beam reaction are calculated for a given experimental arrangement with given energy and angular resolution. Two experimental arrangements are considered in detail: a symmetrical arrangement and an asymmetrical arrangement. Higher-order contributions to the radiative corrections are estimated with the use of renormalization-group techniques. A calculation is given of vector-meson resonant contributions to colliding beam reactions in the one-photon channel and possible resonant effects in the two-photon channel are considered. Some remarks on spin-polarization effects and about contributions to vacuum polarization are also made. (auth)

11753 FERMIONS AND ASSOCIATED BOSONS OF ONE-DIMENSIONAL MODEL. Uhlenbrock, D. A. (Inst. for Advanced Study, Princeton, N. J.). Commun. Math. Phys., 4: 64-76(1967).

The representation of the canonical commutation relations involved in the construction of boson operators from fermion operators according to the recipe of the neutrino theory of light is studied. Starting from a cyclic Fock-representation for the massless fermions the boson operators are reduced by the spectral projectors of two charge-operators and form an infinite

direct sum of cyclic Fock-representations. Kronig's identity expressing the fermion kinetic energy in terms of the boson kinetic energy and the squares of the charge operators is verified as an identity for strictly selfadjoint operators. It provides the key to the solubility of Luttinger's model. A simple sufficient condition is given for the unitary equivalence of the representations linked by the canonical transformation which diagonalizes the total hamiltonian. (auth)

11754 CONTRIBUTION OF THE VIRTUAL COMPTON-EFFECT TO THE CROSS SECTION FOR ELECTRON–POSITRON PAIR PRODUCTION. Zhuravlev, V. I.; Solovev, L. D. Yadern. Fiz., 4: 1210-13(Dec. 1966). (In Russian).

Using the data on meson (ρ^0) photoproduction the contribution of strong interactions to the cross section for the lepton pair photoproduction, due to the virtual Compton effect in the energy range from 5 to 20 GeV, is estimated. (auth)

11755 ENERGY DEPENDENCE OF PHOTONUCLEAR EFFECT AND MUON INTENSITY UNDER ROCK. Castagnoli, C.; Picchi, P.; Scrimaglio, R. (CNEN, Frascati, Italy). Nucl. Phys., 87: 641-9(1967).

An attempt is made to verify the high-energy behavior of the photonuclear cross section σ_γ which is expected to be dominated by the exchange of a Regge pole, by analyzing the information on the intensity-depth curve of muons under rock. The nuclear interactions of high-energy muons are first discussed and calculations are compared with the available data on muons at the accelerators or under rock. Then the muon integral spectrum obtained from under-rock results and from our range-energy relation are compared with the one measured directly at sea level. It is concluded that there is no evidence of the supposed energy dependence of the cross section. (auth)

11756 PAIR ANNIHILATION WITH ONE PHOTON OBSERVED. Anders, Till B. (Univ., Freiburg i. B.). Nucl. Phys., 87: 754-74(1967).

The contribution of the annihilation of electron pairs into three quanta (pa3) to the observable cross section, i.e., the bremsstrahlung correction was calculated with respect to a class of experiments in which only one annihilation photon is analyzed. Three types of experiments are considered, annihilation of positons by the negatons of a target and analysis of the momentum of the one photon emitted (i) at a well-defined angle or (ii) with an energy falling into a narrow range and (iii) annihilation of colliding beams in the center of momentum system and measurement of one photon with high angular resolution. The calculation is carried out with the help of an application of the substitution law to the bremsstrahlung correction of the Compton scattering. The bremsstrahlung correction as well as the elastic radiative correction is tabulated for the three experimental arrangements at input energies between 1 and 10^5 MeV. The pair annihilation can be used as a source of high-energy photons. In view of this application the γ-spectrum due to the process pa3 is also considered. (auth)

11757 COMPTON SCATTERING WITH DETECTED RECOIL ELECTRON. Anders, Till B. (Univ., Freiburg i. B.). Nucl. Phys., 87: 721-53(1967).

The contribution of the double Compton effect to the observable cross section, i.e., the bremsstrahlung correction, was derived for a class of Compton scattering experiments in which the recoil electron is analyzed. The calculation was performed up to the order α^3 of perturbation theory without recourse to any further approximations. The double Compton cross section was evaluated and integrated analytically over the directions of the unobserved secondary photons with fixed momentum of the recoil electron. The integration over the momentum uncertainty of the detected recoil electron was performed numerically. The momentum range of the detector is assumed to be well defined with respect to either the scattering angle (case A) or the energy of the recoil electron (case E) but arbitrary in the remaining dimensions. For both cases A and E, the bremsstrahlung correction as well as the elastic radiative correction was tabulated at different input energies between 1 and 10^6 MeV in the lab system. The best conditions for testing quantum electrodynamics or checking the radiative corrections are discussed. (auth)

11758 PARTIAL CONSERVATION OF TENSOR CURRENTS AND PAULI INTERACTION. Krolikowski, W. (International Atomic Energy Agency, Trieste, Italy). Nucl. Phys., 87: 650-6 (1967).

It is shown that the form of the partial conservation tensor currents (PCTC) proposed recently should be modified if, for the momentum transfer equal to zero, matrix elements of tensor currents have to be finite and vector meson vertices different from zero. (auth)

11759 S-MATRIX THEORY OF ELECTROMAGNETIC INTERACTIONS. Chou, Tsu-teh; Dresden, Max (State Univ. of New York, Stony Brook). Rev. Mod. Phys., 39: 143-66(Jan. 1967).

The possibility of applying the principles of the S-matrix theory to electrodynamics is studied. By using an approximation scheme different from that in the strong interactions, many results of quantum electrodynamics can indeed be reproduced. While the calculations of electrodynamical problems can be carried out in a more straightforward and less laborious way in the S-matrix theory, there still are some basic difficulties. However, as far as scattering processes and the anomalous magnetic moment are concerned, there is complete identity (up till fourth order) between the two methods. The bound-state problem, infrared divergence, and the many-particle problem remained unsettled. (auth)

11760 NON-DYNAMICAL STRUCTURE OF PHOTOPRODUCTION PROCESSES. Csonka, Paul L.; Moravcsik, Michael J.; Scadron, Michael D. (Univ. of California, Livermore). Rev. Mod. Phys., 39: 178-202(Jan. 1967).

The general properties of photoproduction processes which are independent of the interactions among particles are summarized. The two types of reactions considered in detail are $\gamma + 1/2 \rightarrow s + 1/2$ and $\gamma + 1/2 \rightarrow s + 3/2$, where $1/2$ and $3/2$ denote particles with spins $1/2$ and $3/2$, respectively, and s denotes a particle with an arbitrary integer spin s. The first of these reactions is synthesized from the reactions $\gamma + 0 \rightarrow 0 + 0$, $0 + 1/2 \rightarrow 0 + 1/2$, and $0 + 0 \rightarrow s + 0$. First the observable structure of these constituent reactions is derived, and then the composite structure is obtained. Detailed results for the observables are given for $s = 0$, 1, and 2, and experiments designed to determine spin and parity are listed. The reaction $\gamma + 1/2 \rightarrow s + 3/2$ is similarly composed of $\gamma + 0 \rightarrow 0 + 0$, $0 + 1/2 \rightarrow 0 + 3/2$, and $0 + 0 \rightarrow s + 0$. Some results for this reaction are also tabulated. Finally, as a specific application of the above results, a method is suggested to determine the contribution of certain corrections to the static theory of pion photoproduction from nucleons. The discussion is an application of the general nondynamical theory of particle reactions with arbitrary spins. (auth)

Weak

Refer also to abstract 12115.

11761 (JINR–P-2779) VZAIMODEISTVIE NEITRINO S RELYATIVISTSKIMI ELEKTRONAMI. (Neutrino Interactions With Relativistic Electrons). Vanzha, A.; Lapidus, L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1966. 11p. (In Russian). Dep. mn.

The narrowing effect of the neutrino during interactions with relativistic electrons, leading to elastic scattering and to transformation into pairs of $\mu + \nu_\mu$ was examined. The V-A theory leads to the fact that in processes of electron-neutrino interactions with electrons, the energy spectrum is uniform. In processes of antineutrino-electron interactions the mean energy of the neutrino after interaction is close to $1/4$ of the energy of the relativistic electron in the initial state. (tr-auth)

11762 WEAK INTERACTIONS. Cabibbo, N. (CERN, Geneva). pp 1-96 of Brandeis University Summer Institute in Theoretical Physics, 1965. Vol. II. Chretien, M.; Deser, S. (eds.). New York, Gordon and Breach Science Publishers, Inc., 1966.

The topics discussed in weak interactions are the V-A theory and its experimental basis, leptonic versus nonleptonic decays and the CVC hypothesis, the general structure of lepton processes, first and second class currents, and time reversal, and tests of CVC. Also considered are the axial current and meson (π) emission, SU(3) and weak currents, and the accuracy of the SU(3) scheme. (J.F.P.)

11763 SUM RULES AND DYNAMICS. Amati, D. (CERN, Geneva. Univ., Trieste, Italy); Jengo, R. Phys. Lett., 24B: 108-11(Jan. 23, 1967).

The relation between current algebra sum rules and dynamical assumptions is discussed. It is shown that the unsubtractness assumption, which leads to the Fubini sum rule, is untenable in certain kinematical configurations. The discussion of a Reggeized dynamics allows to justify such sum rule and to understand the peculiar singularities present in it. (auth)

11764 INTERFERENCE OF $K_L \rightarrow \pi^+\pi^-$ AND $K_L \rightarrow \pi^+\pi^-$ DECAYS IN CORRELATION EXPERIMENTS WITH $K^0\overline{K}^0$ PAIRS. Lyuboshits, V. L.; Okonov, E. O. Yadern. Fiz., 4: 1194-1201 (Dec. 1966). (In Russian).

It is shown that an investigation of interference effects in correlation experiments with $K^0\overline{K}^0$ pairs makes it possible to determine the magnitude and relative phase of a small admixture of states with even (or odd) orbital momenta in the $K^0\overline{K}^0$ system. (auth)

11765 FOUR-LEPTONIC DECAYS OF CHARGED PIONS AND KAONS AND POSSIBLE ANOMALOUS INTERACTIONS OF LEPTONS. Okun, L.; Pontekorvo, B.; Rubbia, K. Yadern. Fiz., 4: 1202-6(Dec. 1966). (In Russian).

Four-leptonic decays of the type $\pi \rightarrow e\nu e^+e^-$ and $K \rightarrow e\nu\mu^+\mu^-$ are discussed with the aim of clarifying whether their experimental investigations can give information on the validity limits of quantum electrodynamics and on the possibility that there exist additional interactions of leptons of the type $(\bar{e}e)(\bar{e}e)$, $(\bar{\mu}\mu)(\mu\bar{\mu})$ or $(\bar{e}e)(\bar{\mu}\mu)$. It is shown that available experimental data on the validity of quantum electrodynamics require the branching ratios of $\pi \rightarrow e\nu e^+e^-$ and $K \rightarrow e\nu\mu^+\mu^-$ to be less than 10^{-9} of the total decay rates of π and K mesons. (auth)

Strong (General)

Refer also to abstract 11824.

11766 SELF-CONSISTENT DYNAMICAL MODELS. Cutkosky, R. E. (Carnegie Inst. of Tech., Pittsburgh). pp 97-323 of Brandeis University Summer Institute in Theoretical Physics, 1965. Vol. II. Chretien, M.; Deser, S. (eds.). New York, Gordon and Breach Science Publishers, Inc., 1966.

The presentation of self-consistent dynamical models includes an introduction to bootstrap theory, analytical methods, general symmetry properties of bootstrap equations, and bootstrap models. (J.F.P.)

Strong (Baryon No. = 0)

Refer also to abstract 11754.

11767 (IC-66/115) STRESS TENSOR AND THE 2^+ MESONS. Delbourgo, R.; Salam, Abdus; Strathdee, J. (International Centre for Theoretical Physics, Trieste (Italy)). Dec. 1966. 30p. Dep. mn.

It is suggested that the recently discovered 2^+ particles have the stress tensor $\theta_{\mu\nu}$ and its octet generalizations $\theta_{\mu\nu}$ as their sources. Consequences of this hypothesis are examined. (auth)

11768 (INP-496/PL) THE SUM RULE FOR THE FOUR PION COUPLING CONSTANT RESULTING FROM CURRENT ALGEBRA. Kwiecinski, Jan (Institute of Nuclear Physics, Krakow (Poland)). Oct. 1966. 7p. Dep.

The sum rule for the off mass shell $\pi\,\pi$ scattering amplitude at the symmetry point $s = t = u = 0$ is derived using the current algebra. (This amplitude is assumed to be approximately equal to the four pion coupling constant λ.) The sum rule is saturated by the appropriate single particle contributions. The obtained value $|\lambda| \cong 0.15$ is in agreement with other predictions of this constant. (auth)

11769 (NP-16423) ETUDE DES COLLISIONS QUASI-ELASTIQUES ANTIPROTON-PROTON A 3 GeV/c. (Studies of Quasi-Elastic Antiproton-Proton Interactions at 3 GeV/c). Doporto, Martial (Lyon Univ. (France). Faculte des Sciences). June 25, 1965. 36p. (In French). Dep. mn.

Thesis.

The collision of antiprotons with 3 Gev/c linear momentum was studied in order to examine the possibilities offered by the photographic emulsion technique and to determine what procedures can be most advantageously used to establish the collision kinematics. The mathematical study of the kinematics of quasi-elastic collisions led to expressions which, in principle, make it possible to determine the three components of the linear moment of the internal nucleon. The lack of precision of the data and the complexity of the equations obviated their use in the present study. The experimental study showed clearly the need for sufficient precision on the angular determinations, not a fundamental difficulty, but one which required that the distortion of the emulsions be small. There must be very good determination of the energy of the recoil proton. The energy of the incident particle must be well known as the measurement in the emulsion was impossible. (J.S.R.)

11770 SELECTION RULES IN ANTIPROTON-PROTON AND ANTIPROTON-NEUTRON ANNIHILATIONS. Laverriere, R.; Proriol, J. (Institut de Physique Nucleaire, Lyon). Nucl. Phys., 87: 706-20(1967).

Selection rules are given for the annihilation reactions of $\bar{p}p$ and $\bar{p}n$ systems into pion, kaon, hyperon and resonance systems. In every table the interdictions from the various conservation laws are noted. (auth)

Strong (Baryon No. = 1)

11771 (JINR-P2-3081) DISPERSIONNYE PRAVILA SUMM DLYA π P- I Kp-RASSEYANII. (Dispersion Sum Rules for π p- and Kp-Scattering). Zhuravlev, V. I.; Rerikh, K. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 9p. (In Russian). Dep. mn.

An analysis was made of dispersion sum rules, obtained in the work by Logunov, Soloviev, and Tavkhelidze, which connect the high-energy scattering parameters with the integrals of low-energy cross sections. (auth)

11772 FERMION REGGE POLES AND RELATIONS BETWEEN PHASE SHIFTS IN THE PION-NUCLEON SCATTERING. Meng, Ta-chung (Univ., Mainz). Z. Phys., 198: 538-47(1967).

A Regge pole model is proposed. It is shown that simple relations between the small πN phase shifts can be obtained without using any Regge pole parameters. (auth)

11773 Ω^- AS A BOUND STATE IN THE $\Xi\bar{K}$ SYSTEM. Borse, G. J. (Univ. of Virginia, Charlottesville). Nucl. Phys., 87: 785-8(1967). (ORO-2915-66).

A nonrelativistic effective range theory is applied to the $\Xi\bar{K}$ system, using SU(3) to obtain expressions for the phase shifts. A bound state with a mass of 1651 MeV and with the same quantum numbers as the Ω^- is found. (auth)

11774 STUDY OF THE $\pi\pi$ S-WAVE PHASE SHIFT IN THE ρ REGION TAKING INTO ACCOUNT ABSORPTION EFFECTS. Gutay, L. J. (Purdue Univ., Lafayette, Ind.); Johnson, P. B.; Loeffler, F. J.; McIlwain, R. L.; Miller, D. H.; Willmann, R. B.; Csonka, P. L. Phys. Rev. Lett., 18: 142-5(Jan. 23, 1967).

A model is discussed for determining the $\pi\pi$ I = 0, S-wave phase shift in the ρ region under certain assumptions about the effects of absorption on the differential cross section for the reactions $\pi^- + p \rightarrow \pi^+ + \pi^- + n$. The results of applying the model to data from the π^--p interactions at 2.7 GeV/c are presented. (L.B.S.)

11775 POLARIZATION TEST FOR CUTS IN ANGULAR MOMENTUM. de Lany, Vincent M. (Harvard Univ., Cambridge, Mass.); Gross, David J.; Muzinich, I. J.; Teplitz, V. L. Phys. Rev. Lett., 18: 149-52(Jan. 23, 1967).

It is shown that cuts in the angular-momentum plane are natural explanations of the polarization in π^-p charge exchange, which does not decrease rapidly with energy. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstract 11823.

11776 CALCULATION OF THE PARTIAL-WAVE ABSORPTIONS AND OF THE MODULI OF THE ELASTIC AMPLITUDES IN NUCLEON-NUCLEON SCATTERING BELOW 1.4 GeV. Amaldi, U. Jr.; Biancastelli, R.; Francaviglia, S. (Istituto Superiore di Sanita, Rome). Nuovo Cimento (10), 47A: 85-112(Jan. 1, 1967).

The usual procedure to compute partial-wave absorptions in pion-pion and pion-nucleon scattering from the knowledge of inelastic processes is extended to the nucleon-nucleon case and applied to the range 550 to 1400 MeV of laboratory kinetic energies. One-pion production, which is the only important inelastic channel, is described by means of the well-known peripheral model modified by the introduction of form factors. Contrary to general belief, the results show that this model does not violate any of the unitarity conditions, which in the present case are not at all trivial due to the nondiagonal character of the S-matrix in the angular momentum representation. From the computed absorptions the moduli of the partial-wave elastic matrix elements are obtained. After a careful discussion, which shows that the results are trustworthy in the 800 to 1400 MeV energy range, the absorptions are compared with the data of a published phase shift analysis performed at 970 MeV and suggestions are made on the best starting point of future phase shift searches. Finally the possible use of absorptions as known inelasticities to be introduced in partial-wave dispersion relations is outlined. It must be stressed that the results do not depend upon the interpretation of the cut-off function appearing in the inelastic matrix elements as true pionic form factor. (auth)

11777 $\pi^{\pm}$-^{4}He SCATTERING AND THE PION ELECTROMAGNETIC FORM FACTOR. Ericson, M. (Univ., Lyon). Nuovo Cimento (10), 47A: 49-56(Jan. 1, 1967).

The scattering of pions by ^{4}He is discussed in relation to a proposed experiment to determine the pion form factor. The s and p phase shifts are calculated. It is shown that it is necessary to carefully account for the mixing of the Coulomb and strong-interaction effects. (auth)

11778 ELASTIC pp-SCATTERING PHASE SHIFT ANALYSIS AT 657 MeV WITH ACCOUNT OF ONE-BOSON EXCHANGE AND RELATIVISTIC COULOMB EFFECTS. Azhgirei, L. S. Yadern. Fiz., 4: 1248-50(Dec. 1966). (In Russian).

The phase shift analysis of experimental data on the elastic pp-scattering near to 660 MeV was performed, taking relativistic corrections and proton form factors into account in the Coulomb scattering. The exchange of a scalar boson and two vector ones was taken into account, besides the one pion exchange, in calculating the phase shifts of higher states in the pp system. The one-boson exchange proves to be significant for a description of the proton polarization data at small angles. (auth)

11779 REGGE CUT IN PROTON–PROTON SCATTERING. Huang, K.; Jones, C. E.; Teplitz, V. L. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett., 18: 146-8(Jan. 23, 1967).

It is pointed out that a break recently discovered in the differential cross section for p-p scattering as a function of energy at $\Theta = 90^0$ may be explained in terms of a Regge cut. An attempt is made to see whether a mechanism can be found that leads naturally to the observed phenomena. A model is developed assuming first that the scattering amplitude is given by a Regge formula without the background term. A comparison between experiment and theory is shown. (L.B.S.)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 11809 and 11814.

11780 (JINR–P2-3078) VYROZHDENNYE UNITARNYE PREDSTAVLENIYA GRUPPY SU(2,2) I SIMMETRIYA ELEMENTARNYKH CHASTITS. (Degenerate Unitary Representations of the SU(2,2) Group and Elementary Particle Symmetry). Cao Chi (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 14p. (In Russian). Dep. mn.

Two series of degenerate unitary representations of the SU(2,2) group were found previously. It is proved that one of these two series (the principal one) belongs to the so called Graev d_1 series. Besides, a possible application of the principal series representations to the elementary particle symmetry theory is pointed out. The SU(2,2) $\{SU(2) \times SU(2) \times U(1)\}_p$ reduction is given where p is four-momentum of particle. Particles are classified according to irreducible representations of the maximal compact subgroup. The vertex of interaction of an infinite multiplet with a scalar external field is briefly considered. (auth)

11781 RELATIVISTIC INVARIANCE AND INTERNAL SYMMETRIES. Michel, L. (Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France). pp 247-357 of Brandeis University Summer Institute in Theoretical Physics, 1965. Vol. I. Chretien, M.; Deser, S. (eds.). New York, Gordon and Breach Science Publishers, Inc., 1966.

The discussion of relativistic invariance and internal symmetries includes group theory and group extensions, homogeneous space and the Zeeman theorem, observables and algebras, and polarization. Emphasis is given to the Zeeman theorem. (J.F.P.)

11782 SUPERMULTIPLET STRUCTURE RESULTING FROM THE EXISTENCE OF Q_K. Rolnick, William B. (Wayne State Univ., Detroit). Phys. Rev. Lett., 18: 225-6(Feb. 6, 1967).

The possibility of combining SU(3) with $U(1)(Q_K)$ to obtain a nontrivial compact local Lie group whose algebra contains a maximal Abelian subalgebra spanned by I_Z, Y, and Q_K is examined. If the simple Lie groups are ruled out (on physical grounds), it is shown that the only possibility remaining is a direct product SU(3) and a group containing $U(1)(Q_K)$. Thus, the Q_K and SU(3) assignments are not linked by the group and no nontrivial supermultiplet structures ensues. (auth)

11783 REDUCTION OF IRREDUCIBLE UNITARY REPRESENTATIONS OF THE POINCARE GROUP AND THE EUCLIDEAN GROUP. Bertrand, Jacqueline (Institut Poincare, Paris). Ann. Inst. Henri Poincare, Sect. A, 5: 235-56(1966). (In French).

Mackey's theory of induced representations is applied to the irreducible unitary representations of the Poincaré group and their global form is found in an angular momentum basis. The method is direct, mathematically rigorous and general: imaginary mass representations as well as real ones could be considered. Finally, the infinitesimal generators for physical and infinite spin representations are computed. (auth)

11784 IRREDUCIBLE REPRESENTATIONS OF THE UNITARY AND LORENTZ GROUPS. Anderson, Robert L. (General Motors Corp., Warren, Mich.); Gupta, Suraj N.; Repko, Wayne W. Nucl. Phys., 87: 789-800(1967).

The irreducible representations of the unitary and Lorentz groups are derived by a method, in which the generators are treated by means of differential operators, while the irreducible tensors are expressed as polynomials by using the components of two basic vectors as independent variables. Our treatment is simpler than the earlier derivations of the irreducible representations, since it completely avoids the use of the complicated mathematical apparatus of the standard group theory. (auth)

11785 CONSERVED TENSOR CURRENTS AND THE RELATIVISTIC STRUCTURE OF THE SU(6) GROUP. Ogievetskii, V. I.; Polubarinov, I. V. Yadern. Fiz., 4: 1231-47(Dec. 1966). (In Russian).

It is shown that conserved tensor currents generate SU(6) transformations. A relation is established between the constructed currents and the pseudovector currents of the so called algebra of currents. The obtained relativistic transformations leave the free equations invariant, but should be modified if interactions are switched on. In the true theory involving interactions the transformations and currents are likely to become essentially nonlinear. Only if applied to one-particle states and static effects a future true group will be reduced to SU(6). Under the hypothesis that tensor currents are sources of 2^+ fields the fundamental role of the 189 supermultiplet is pointed out. (auth)

11786 NON-COMPACT GROUPS IN PARTICLE PHYSICS. Proceedings of 1966 Conference held at The University of Wisconsin-Milwaukee, May 5–6, 1966. Chow, Yutze (ed.). New York, W. A. Benjamin, Inc., 1966. 221p. (CONF-660540–).

Eleven papers and concluding remarks are included; separate abstracts are prepared for five papers. Six papers were previously abstracted for NSA; see CONF 660540 in the report number index. (L.B.S.)

For abstracts of individual papers see: 11787, 11788, 11799, 11800, and 11809.

11787 UNITARY REPRESENTATIONS OF THE NON-COMPACT FAMILY OF GROUPS SU(p,1). Biedenharn, L. C. (Duke Univ., Durham, N. C.). pp 23-41 of Non-Compact Groups in Particle Physics. Chow, Yutze (ed.). New York, W. A. Benjamin, Inc., 1966.

It is shown that the well developed algebraic techniques for constructing explicitly the unitary irreducible representations of SU(n) may be exploited to construct the unitary irreducible representations of SU(p,q). The content of the method is illustrated by considering the problem of constructing all the irreducible representations of SU(1,1) out of a few basic representations (the discrete series). The algebraic method is generalized first to SU(2,1) and then to SU(p,1). (L.B.S.)

11788 COROLLARY TO MASS-SPLITTING THEOREM. O'Raifeartaigh, L. (Syracuse Univ., N. Y.). pp 79-88 of Non-Compact Groups in Particle Physics. Chow, Yutze (ed.). New York, W. A. Benjamin, Inc., 1966.

Two proofs are given of the following corollary to the mass-splitting theorem: Let g denote any real parameter (finite-order) semi-simple connected Lie group containing the proper orthochronous Poincaré group P as a subgroup. There in any continuous unitary representation U(g) of g on a Hilbert space H, (a) the spectrum of the mass^2-operator M^2 of P is not bounded below by any positive number; (b) if m^2 is an isolated eigenvalue of M^2, then $m^2 \leq 0$. (L.B.S.)

11789 BRANDEIS UNIVERSITY SUMMER INSTITUTE IN THEORETICAL PHYSICS, 1965. PARTICLE SYMMETRIES AND AXIOMATIC FIELD THEORY. VOLUME II. PARTICLE SYMMETRIES. Chretien, M.; Deser, S. (eds.). New York, Gordon and Breach Science Publishers, Inc., 1966. 690p. $35.00.

The book included 6 chapters one of which was abstracted previously in NSA. For an abstract of this paper see abstract number 20: 19448. Separate abstracts were prepared for 5 papers. (J.F.P.)

For abstracts of individual chapters see: 11762, 11766, 11790, 11791, and 11798.

11790 SU(6) IN PARTICLE PHYSICS. Lee, B. W. (Univ. of Pennsylvania, Philadelphia). pp 324-451 of Brandeis University Summer Institute in Theoretical Physics, 1965. Vol. II. Chretien, M.; Deser, S. (eds.). New York, Gordon and Breach Science Publishers, Inc., 1966.

A critical review of the relevance of the SU(6) group to particle physics is given. Tensor representations of SU(n), the nonrelativistic model of SU(6), the relativistic version of SU(6), and the algebra of current components are considered. (J.F.P.)

Applications (Electromagnetic and Weak)

Refer also to abstract 11799.

11791 POSSIBLE C NON-INVARIANCE IN THE ELECTROMAGNETIC INTERACTION. Lee, T. D. (Columbia Univ., New York). pp 453-72 of Brandeis University Summer Institute in Theoretical Physics, 1965. Vol. II. Chretien, M.; Deser, S. (eds.). New York, Gordon and Breach Science Publishers, Inc., 1966.

Present knowledge concerning C and P is summarized, and the total lack of experimental evidence of C conservation in the electromagnetic interaction is noted. The logical distinction between the charge conjugation operator for strong and that for electromagnetic interactions is emphasized, and various theoretical possibilities implied by the discovery of the 2π decay mode of the meson (K_2^0) are presented. (J.F.P.)

11792 SATURATION OF A CHARGE-CURRENT ALGEBRA. Albright, C. H. (Northwestern Univ., Evanston, Ill.). Phys. Lett., 24B: 100-3(Jan. 23, 1967).

The origin of poor predictions for the weak N−N* coupling constants obtained by saturating a chiral U(6) ⊗ U(6) charge-current algebra is studied and arguments are presented concerning the use of unsubtracted dispersion relations, the absence of Schwinger terms, and the validity of the saturation procedure itself. (auth)

11793 SU(6) SYMMETRY AND THE MESON PHOTOPRODUCTION ON THE PROTON. Nelipa, N. F. (Lebedev Inst. of Physics, Moscow). Nucl. Phys., 87: 703-5(1967).

The process of meson photoproduction on the proton are considered using SU(6) symmetry. (auth)

11794 ELECTROMAGNETIC CURRENT AND FORM FACTORS FOR THE MESON 35-PLET IN THE BROKEN SL(6,C)-SYMMETRY. Winternitz, P.; Zubarev, A. L.; Makarov, A. A. Yadern. Fiz., 4: 1223-6(Dec. 1966). (In Russian).

The structure of the electromagnetic meson current is investigated in the framework of the SL(6,C) symmetry and it is shown that the current depends on three form factors. The results are compared with the U(6,6) theory. (auth)

11795 LEPTONIC DECAYS OF HYPERONS. Alekseev, I. I.; Sokolovskii, R. I. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 4: 1191-3(Dec. 1966). (In Russian).

The probabilities of the weak decays of hyperons were calculated using the relativistic generalization of the SU(6) symmetry, suggested by Golfand. The obtained results are in good agreement with the available experimental data. (auth)

Applications (Strong)

Refer also to abstract 11792.

11796 (JINR-P2-3069) ROZHDENIE BARIONNYKH REZONANSOV I KOLLINEARNYE SIMMETRII. (Baryon Resonance Production and Collinear Symmetries). Winternitz, P.; Kasymzhanov, M. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 8p. (In Russian). Dep. mn.

The reconstruction of the scattering matrix is considered for the collinear production of baryon resonances in baryon collisions. Predictions following from collinear symmetries are investigated. (auth)

11797 PHYSICS OF THE SU(3) SYMMETRY MODEL. Ram, Budh (Univ. of North Carolina, Chapel Hill). Amer. J. Phys., 35: 16-23(Jan. 1967).

The basic ideas of the SU(3) symmetry model of strongly interacting particles are clearly explained. (auth)

11798 SYMMETRIES AND ELEMENTARY PARTICLES. Low, F. E. (Massachusetts Inst. of Tech., Cambridge). pp 473-593 of Brandeis University Summer Institute in Theoretical Physics, 1965. Vol. II. Chretien, M.; Deser, S. (eds.). New York, Gordon and Breach Science Publishers, Inc., 1966.

Symmetry principles for strong interactions are considered. The spectrum of the particles is discussed, and symmetry principles are applied to give an overall phenomenological picture of the strong interactions. The symmetries discussed in detail are space inversion, charge conjugation, time reversal, PCT, isotopic spin, G parity, SU(3) (quite completely but without group theory), and A parity. (J.F.P.)

11799 REPRESENTATIONS OF THE ALGEBRA OF CURRENT DENSITIES. Dashen, R. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. pp 69-77 of Non-Compact Groups in Particle Physics. Chow, Yutze (ed.). New York, W. A. Benjamin, Inc., 1966. (CALT-68-74).

A concrete physical formulation is given of some ideas for finding a classification of hadron states according to simple approximate representations of the local algebra, obtaining at the same time predictions for couplings and form factors. (L.B.S.)

11800 INTERNAL DYNAMICS OF MESONS AND BARYONS AND NON-COMPACT GROUPS. Sinanoglu, O. (Yale Univ., New Haven). pp 119-42 of Non-Compact Groups in Particle Physics. Chow, Yutze (ed.). New York, W. A. Benjamin, Inc., 1966.

The connection between various nonrelativistic quark models and their noncompact groups is discussed. First a very simple model of V(6,6) towers with increasing $n_q + n_{\bar{q}}$ (number of quarks and antiquarks) is briefly discussed. The meson spectrum and the dynamical noncompact groups of orbital excitation indicated by it are then considered. Finally a discussion is given of more general noncompact groups that would be called for by combined $N = n_q + n_{\bar{q}}$ and, L and other dynamical excitations in models. (L.B.S.)

11801 NONLEPTONIC FOUR-FERMION ΔS = 1 INTERACTIONS AND SU(3)-SYMMETRY. Radutskii, G. M.; Tabachenko, A. N.; Filimonov, V. A. Yadern. Fiz., 4: 1227-30(Dec. 1966). (In Russian).

Relations between amplitudes of the nonleptonic four-fermion $\Delta S = 1$ interactions are found from the isospin selection rule $|\Delta I| = 1/2$ and assuming that the hadron weak interaction lagrangian transforms like the components of an SU(3)-octet. (auth)

11802 MASS FORMULAS IN SU(12) ⊃ Sp(6) ⊗ SU(2)-SYMMETRY. Nikolov, A. V.; Todorov, I. T.; Fakirov, D. G. Yadern. Fiz., 4: 1214-22(Dec. 1966). (In Russian).

The SU(12)-symmetry combining SU(2) spin group and Sp(6) symplectic inner group with basic multiplets ("trions") consisting of particles with integer electric and baryon charges and half-integer spin is studied. Mass formulas are obtained for mesons and baryons belonging to the representations 143 and 364 respectively under the assumption that the mass operator in the broken SU(12)-symmetry conserves not only spin, isospin and strangeness but also the supercharge. For the known particles (with zero supercharge) the usual mass formulas obtained in the SU(6)-symmetry scheme are reproduced. (auth)

11803 INTRODUCTION TO UNITARY SYMMETRY. Carruthers, Peter A. Interscience Tracts on Physics and Astronomy. New York, Interscience Publishers, 1966. 234p. $5.95.

The use of unitary symmetry in strong interactions is outlined. The topics discussed include angular momentum and isospin in SU(2), SU(3) symmetry in strong interactions, construction and general properties of representations of SU(3), SU(3)-invariant vertices and amplitudes, broken SU(3), and crossing symmetry of strong interactions. Appendices include tables of isoscalar factors and a discussion of vector and axial vector currents. (C.E.S.)

Quantum Field Theories

Refer also to abstract 11765.

11804 (DESY-66/24) EQUAL TIME COMMUTATORS OF RENORMALIZED CURRENT OPERATORS IN PERTURBATION THEORY. Langerholc, J. (Hamburg Univ. (West Germany). Institut fuer Theoretische Physik (II). Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Oct. 1966. 11p. Dep. mn.

The conjectures derived by applying canonical commutation relations to formally defined currents are tested by forming the actual commutators of the renormalized current operators obtained from perturbation theory (up to second order) and taking an equal time limit. It is shown that consideration of renormalization phenomena leads to conclusions differing from those obtained in previous perturbational calculations; in certain models the commutator of two zeroth components of vector or axial vector currents diverge at equal times. (auth)

11805 (NP-16460) TEMPERED DISTRIBUTIONS IN INFINITELY MANY DIMENSIONS. III. LINEAR TRANSFORMATIONS OF FIELD OPERATORS. Kristensen, P.; Mejlbo, L.; Poulsen, E. Thue (Aarhus Univ. (Denmark)). Nov. 1966. 31p. Dep. mn.

The linear homogeneous transformations of the canonical pair of field operators, in particular linear transformations induced by the real symplectic group over Schwartz's space, were investigated. (B.G.D.)

11806 AMBIGUOUS INTEGRAL IN QUANTUM ELECTRODYNAMICS. Pugh, Robert E. (Univ. of Toronto). Can. J. Phys., 45: 1-5(Jan. 1967).

An integral that appears in several contexts in quantum electrodynamics is evaluated without the usual ambiguity. The result is applied to (1) the contribution of vacuum polarization to the interpolating photon field, (2) wave-function renormalization, and (3) a gauge-independent formulation of quantum electrodynamics. In the first two cases the expected results are obtained, while in

the last case the particular formulation is shown to be, in fact, not gauge invariant. (auth)

11807 POSSIBILITY OF FINITENESS OF ORDINARY QUANTUM ELECTRODYNAMICS. Johnson, K.; Willey, R.; Baker, M. Zh. Eksp. Teor. Fiz., 52: 318-26(Jan. 1967). (In Russian).

The photon wave function constant Z_3 is calculated under the assumption of absence of infinities in quantum electrodynamics. The result is that Z_3^{-1} diverges as the first power of the logarithm of Λ (ultraviolet cut-off parameter). The result is discussed within the framework of perturbation theory. (auth)

11808 RANGE OF FORCES AND BROKEN SYMMETRIES IN MANY-BODY SYSTEMS. Swieca, J. A. (Univ. of Illinois, Urbana). Commun. Math. Phys., 4: 1-7(1967).

It is argued that for a many-body system with short-range forces the commutators between local operators at different times will be fast decreasing for large spatial separations. This allows the adaptation of many discussions in relativistic field theories to the case of a many-body system with short-range forces. In particular one has the result that a spontaneous breakdown in symmetry implies the existence of excitations of arbitrarily small energy. However this result has essentially only one application. It is known that the Galilei invariance is always broken (in a medium of finite density). Therefore one concludes that in a many-body system with short range forces there can never be an energy gap. (auth)

11809 C*-BUNDLES IN ALGEBRAIC QUANTUM FIELD THEORY. Mayer, M. E. (Indiana Univ., Bloomington. Univ. of California, Irvine). pp 163-80 of Non-Compact Groups in Particle Physics. Chow, Yutze (ed.). New York, W. A. Benjamin, Inc., 1966.

Some partial results are summarized on the utilization of concepts from modern algebraic geometry to quantum field theory, and to the description of symmetries within axiomatic field theory. Pertinent definitions are first introduced, illustrated by some examples of sheaves and fibre bundles. The definition of a C* bundle in then introduced. The physical application consists in two reformulations of the axioms of quantum field theory in terms of C*-bundles for which the base space is either Minkowski space or the Poincaré group. (L.B.S.)

11810 POSSIBILITIES OF OBSERVATION OF NONLINEAR QUANTUM ELECTRODYNAMIC EFFECTS IN VACUUM. Kane, P. P.; Basavaraju, G. (Indian Inst. of Tech., Bombay). Rev. Mod. Phys., 39: 52-8(Jan. 1967).

Experiments that can reveal the nature of the second- and the fourth-order terms in the interaction between charged particles and electromagnetic fields in vacuum are discussed. An attempt is made to emphasize the successes of the experiments already completed and the promising lines of future investigation. The theoretical considerations relevant to the experiments under review are also outlined. In all cases studied so far, the experimental results agree with the predictions of conventional quantum electrodynamics. (auth)

11811 RESTRICTION ON THE INTEGRALS OF LOCAL CURRENTS. Dell'Antonio, G. F. (New York Univ., N. Y.). Nuovo Cimento (10), 47A: 1-8(Jan. 1, 1967).

A generalized version of two theorems proposed by S. Coleman is proved. The proof is based on the usual axioms of quantum field theory. (auth)

11812 AUTOMORPHISMS AND BROKEN SYMMETRIES IN ALGEBRAIC QUANTUM FIELD THEORIES. Guenin, M.; Velo, G. (Princeton Univ., N. J.). Nuovo Cimento (10), 47A: 35-48 (Jan. 1, 1967).

In the framework of Haag-Araki algebraic quantum field theory, it is shown that the existence of a broken symmetry which may be extended to the Hamiltonian implies that the algebra of all quasi-local operators has a nontrivial center which is not left element-wise invariant under the symmetry. (auth)

11813 N-QUANTUM APPROXIMATION IN STATIC MODELS. Pagnamenta, Antonio. College Park, Md., Univ. of Maryland, 1966. 165p.

Thesis.

The N-quantum approximation is a nonperturbative approximation method designed to construct operator solutions to the field equations. The renormalized Heisenberg field operators are approximated by finite-degree normal-ordered expansions in an irreducible set of in-fields. The coefficients of these expansions are c-number functions and are the unknown quantities of this method. The main problem with any nonperturbative approximation scheme is to make it compatible with the renormalization program. It is shown how the N-quantum approximation works in some static models. After explaining the method in the lowest sector of the Lee model, it is used to solve the $V\theta/N2\theta$ sector. The N-quantum approximation can also be applied if bound states are present or if one deals with resonances. This is shown on the example of the $V\theta$-bound state and the unstable V-particle. The method leads to exact results in all the discussions of the Lee model. This is used to derive some properties of the model itself. A short deductive method to solve the singular integral equations (both homogeneous and inhomogeneous) which occur in the higher sector of the Lee model is given and uniqueness of the solutions is shown. High- and low-energy limits of the three-particle amplitudes and their singularities are discussed. The possibility of generation of a three-particle resonance via a two-body resonance is analyzed. In the last part the exact Heisenberg fields for the scalar field interacting with a fixed fermion source are given, and it is shown that the N-quantum approach gives a reasonable and good approximation. A working knowledge of this nonperturbative approximation is given. (auth)

11814 BRANDEIS UNIVERSITY SUMMER INSTITUTE IN THEORETICAL PHYSICS, 1965. PARTICLE SYMMETRIES AND AXIOMATIC FIELD THEORY. VOLUME I. AXIOMATIC FIELD THEORY. Chretien, M.; Deser, S. (eds.). New York, Gordon and Breach Science Publishers, Inc., 1966. 516p. $32.50.

The book included 5 chapters. Separate abstracts were prepared for all chapters. (J.F.P.)

For abstracts of individual chapters see: 11781, 11815, 11816, 11821, and 11822.

11815 ON THE CONNECTION BETWEEN WIGHTMAN AND LSZ QUANTUM FIELD THEORY. Hepp, K. (Inst. for Advanced Study, Princeton, N. J.). pp 135-246 of Brandeis University Summer Institute in Theoretical Physics, 1965. Vol. I. Chretien, M.; Deser, S. (eds.). New York, Gordon and Breach Science Publishers, Inc., 1966.

The Haag-Ruelle collision theory is developed. The connection with the LSZ framework shows up in the asymptotic condition, the reduction formulas and analyticity properties of the 2-particle scattering amplitude. A bridge to a Haag-Araki theory of local rings is established, and the analysis of the S-matrix in quantum field theory is also discussed. (J.F.P.)

11816 ALGEBRAIC ASPECTS OF RELATIVISTIC QUANTUM FIELD THEORY. Robinson, Derek W. (Max Planck Institut fuer Physik, Munich). pp 389-516 of Brandeis University Summer Institute in Theoretical Physics, 1965. Vol. I. Chretien, M.; Deser, S. (eds.). New York, Gordon and Breach Science Publishers, Inc., 1966.

Topics presented in relativistic quantum field theory are relativistic invariance, conventional field theory, and field theory as an algebraic theory of local observables. Some recent results are presented. (J.F.P.)

Scattering Theory

Refer also to abstract 11814.

11817 (BMwF-FBK-66-22) LEE-MODELL MIT COULOMB-WECHSELWIRKUNG. (Lee Model with Coulomb Interaction). Hannover, H. (Muenster Univ. (West Germany). Institut fuer Theoretische Physik). July 1966. 8p. (In German). Dep. mn.

The Hamiltonian of the Lee model in the sector (1,0) with an additional $N\Theta$-interaction is diagonalized by means of Green's operator $(E-H)^{-1}$. In addition to a continuous spectrum of scattering states one gets a discrete spectrum consisting of a ground-state level determined essentially by Lee's interaction H_1, and excited states generated by the additional interaction H_2. The effect on the time law of decay of choosing various density matrices describing unstable particles is briefly discussed. (auth)

11818 (JINR-E2-3077) DISPERSION SUM RULES AND HIGH ENERGY SCATTERING. Logunov, A. A.; Soloviev, L. D.; Tavkhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 6p. Dep. mn.

Dispersion sum rules which connect the high-energy scattering parameters with the integrals of low-energy cross-sections are obtained. (auth)

11819 (N-66-19720) ASYMPTOTIC PROPERTIES OF THE POTENTIALS IN THE INVERSE-SCATTERING PROBLEM AT FIXED ENERGY. Sabatier, Pierre C. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Dec. 1965. 54p. (TH-116). CFSTI $3.00 cy, $0.65 mn.

The problem of finding a nonrelativistic central potential from a knowledge of all the phase shifts at one energy was previously shown by R. G. Newton to reduce to the inversion of a given infinite matrix, M. In the framework of Newton's theory, the solution is not unique but depends on one parameter. In the present work,

the inverse matrix is explicitly given, together with the vectors annihilated by M. These enable the construction of all the solutions of the problem. The asymptotic behavior of the equivalent potentials is exhibited, and it is shown that one and only one of them decreases asymptotically faster than $r^{-2+\epsilon}$, provided that the phase-shifts decrease asymptotically faster than $l^{-(3+\epsilon')}$ (for arbitrarily small ϵ,ϵ'). All the other equivalent potentials have an oscillating tail damped by a factor $r^{-\frac{1}{2}}$. The transparent potentials, which give a phase-shift equal to zero at one energy, are also studied. (auth)

11820 RADIATIVE TRANSFER IN A FINITE MEDIUM. Gnedin, Yu. N.; Dolginov, A. Z. (Inst. of Technical Physics, Academy of Sciences, USSR). Soviet Astron. AJ (Engl. Transl.), 10: 637-45(Jan. Feb. 1967).

Translated from Astron. Zh., 43: 800-12(July-Aug. 1966).

The Maxwell and Schroedinger equations yield equations for the intensity of scattered particles (including photons) outside and inside a medium of finite dimensions. Approximations are given where these equations agree with the standard equation of transfer; the relation between the various forms is considered. In the form suggested, the equation is convenient for studying scattering in bodies of various geometric shapes. An explicit analytic solution is derived for multiple scattering in a plane layer or spherical volume of matter. The cases of isotropic and sharply anisotropic scattering by an individual particle are discussed. (auth)

11821 ANALYTIC PROPERTIES OF SCATTERING AMPLITUDES IN QUANTUM FIELD THEORY. Epstein, H. (Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France). pp 1-133 of Brandeis University Summer Institute in Theoretical Physics, 1965. Vol. I. Chretien, M.; Deser, S. (eds.). New York, Gordon and Breach Science Publishers, Inc., 1966.

The discussion of analytic properties of scattering amplitudes in quantum field theory includes generalized retarded functions, analytic functions of several variables, and properties of the four-point function. No attempt is made to survey the whole field, and the most important omissions are work pertaining to the analytic properties of Wightman functions in x space. (J.F.P.)

11822 INTRODUCTION TO THE QUANTUM MECHANICAL THREE BODY SCATTERING PROBLEM. Newton, R. G. (Indiana Univ., Bloomington). pp 359-87 of Brandeis University Summer Institute in Theoretical Physics, 1965. Vol. I. Chretien, M.; Deser, S. (eds.). New York, Gordon and Breach Science Publishers, Inc., 1966.

The scattering of a particle by a bound state of two others is discussed in the context of nonrelativistic quantum mechanics. The solution must take into account that there are four possibilities: the final configuration of the three particles may be the same as the initial (elastic scattering), the initially bound particles may be raised (or lowered) to another bound state, they may be dissociated and the three particles emerge freely (ionization), and the two particles finally bound together may not be the same as those bound initially (rearrangement collision). The topics include a review of formal scattering theory, modifications for scattering on a bound state, calculation of the T-matrix, and the Faddeev method. (J.F.P.)

11823 IMPROVED FORMULA FOR INTRODUCING ABSORPTIVE CORRECTIONS INTO THE PERIPHERAL MODEL. Squires, Euan J. (Univ. of Durham, Eng.). Nucl. Phys., 87: 801-6(1967).

It is shown how the random-phase method for treating absorptive corrections to the peripheral model can be modified so that some channels, assumed known, are calculated explicitly and the remainder treated by the random-phase method. The new result has the advantage of being always compatible with unitarity. The application of the method to specific problems is discussed. (auth)

11824 TIME DELAY AND RESONANCES IN A THREE-PARTICLE MODEL. Halliday, I. G. (Princeton Univ., N. J.). Nuovo Cimento (10), 47A: 57-62(Jan. 1, 1967).

A time delay formalism is given for a three-particle scattering model. It is then applied to resonance production in 3-particle systems. (auth)

Particle Accelerators

Refer also to abstracts 10519 and 10524.

11825 (JINR-P13-3084) REZONATOR SISTEMY KRATNOGO USKORENIYA PROTONOV SINKHROFAZOTRONA OIYAI. (Resonator of a Proton Multiple Acceleration System in the JINR Synchrophasotron). Vagin, V. A.; Volodin, V. D.; Saenko, A. P.; Semenyushkin, I. N.; Stepanyuk, V. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1966. 13p. (In Russian). Dep. mn.

A design of the multiple acceleration system resonator is chosen. The main parameters are calculated. The methods of depression of a resonance high-frequency division in vacuum 3.10^{-6} mm Hg without magnetic field and in the presence of a scattered magnetic field $H_z \simeq 50$ Oe are described. The results of testing this resonator in the JINR synchrophasotron accelerator are described. (auth)

11826 (LA-3609) PROCEEDINGS OF THE 1966 LINEAR ACCELERATOR CONFERENCE HELD AT THE LOS ALAMOS SCIENTIFIC LABORATORY, NEW MEXICO, OCTOBER 3-7, 1966. (Los Alamos Scientific Lab., N. Mex.). Dec. 1966. Contract W-7405-eng-36. 531p. (CONF-661021-). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Separate abstracts are prepared for 46 of the 79 papers presented. Thirty-three papers were previously included in NSA. For abstract numbers of these papers refer to CONF-661021 in the Report Number Index. (B.G.D.)

For abstracts of individual papers see: 11827-11872.

11827 (LA-3609, pp 229-32) COMPARISON OF THE PARTICLE MOTIONS AS CALCULATED BY TWO DIFFERENT DYNAMICS PROGRAMS. Swenson, D. A. (Los Alamos Scientific Lab., N. Mex.); Young, D. E.; Austin, B. (Midwestern Universities Research Association, Stoughton, Wis.).

A comparison is presented of the PARMILA and LINDY computer codes which are designed to integrate the equations of motion of electrons or ions in the electromagnetic fields of the basic linac geometry. (B.G.D.)

11828 (LA-3609, pp 20-7) THE NBS LINAC. Leiss, J. E. (National Bureau of Standards, Washington, D. C.).

The NBS linear electron accelerator, which is a facility designed for a varied program in nuclear and radiation physics, is discussed. Topics included are accelerator components such as waveguide structures, injectors, microwave system, cooling system, modulators, rf distribution system, and analyzing magnets; facility layouts; and beam handling. (B.G.D.)

11829 (LA-3609, pp 48-59) PROGRESS REPORT ON THE CERN-PS LINAC. Taylor, C. S.; Warner, D. J.; Block, F.; Tetu, P. (European Organization for Nuclear Research, Geneva (Switzerland)).

The behavior of the CERN-PS Linac at currents of 50 to 100 mA is discussed. The difficulties of bunching at the higher currents are first described, and then the transverse beam properties at 50-60 mA, in particular blow-up, are discussed in detail as a background to the behavior at 100 mA. The measures which are being taken to combat beam loading are described, and the heating effects of the high brilliance 500 keV beam mentioned. A method of emittance measurement using a computer is reported, and some comments on our experience with the statistical analysis of machine parameters are given. (auth)

11830 (LA-3609, pp 60-4) RECENT OPERATING EXPERIENCE WITH THE ZGS INJECTOR LINAC. Perry, Rolland (Argonne National Lab., Ill.).

The reliability of the ZGS is outlined after four years of operation. The performance of its major components (preaccelerator, ion source, and rf system) is discussed. Modification to components of the ZGS is reported. These components were the rf system, hydraulic power system for preacceleration, high gradient accelerating column, and variable energy debuncher. A brief review of the experiments in progress is also presented. (B.G.D.)

11831 (LA-3609, pp 78-82) PERFORMANCE CHARACTERISTICS OF THE ZERO GRADIENT SYNCHROTRON LINAC AUTOMATIC GRADIENT STABILIZER. Castor, R. W.; Abraham, J. (Argonne National Lab., Ill.).

The performance characteristics of the 5 Mc and 26 Mc automatic gradient stabilizers for the ZGS linac are reported. (B.G.D.)

11832 (LA-3609, pp 96-103) SELF FOCUSING IN HEAVY ION LINACS. Boussard, D. (Paris Univ., Orsay (France). Faculte des Sciences).

The focusing of the first sections of heavy ion linear accelerators may be achieved without the use of grids or magnetic quadrupoles by employing conveniently ended drift tubes. The ion motion is theoretically studied in a structure using drift tubes which are lengthened by two diametrically opposite fingers. We show that it is possible to ensure simultaneously radial and axial stabilities of the beam. Using a low energy model (200 keV) energy spectrum and current yield of this new structure were measured. Experimental results are very interesting: current yield is as high as 20%, for a 21 drift tubes linac, and it rises above 60% by using a bunching device. These results are in good agreement with the theory, and the construction of self focused linacs seems to be possible with this method. Theoretical results concerning break-

down voltages, trajectories, acceptance, obtained in a real case (injector of the variable energy cyclotron in Orsay) are given. It is concluded that this new method has many attractive features and may be employed successfully to design the first sections of heavy ion linacs. (auth)

11833 (LA-3609, pp 132-6) TUNING AND FIELD MEASUREMENT TECHNIQUES IN A RESONANTLY COUPLED ACCELERATOR TANK. Engel, L. N.; Knapp, E. A. (Los Alamos Scientific Lab., N. Mex.).

The tuning and measurements made on a long cavity chain designed to check the predictions of the theory and develop fabricational and tuning techniques useful for mass production of cavity chains of this type are given. An 805 MHz, side-coupled, 39 accelerating cell, experimental model was fabricated and tuned. Designed to have a constant phase velocity of 0.65 speed of light, this tank was the first accurately fabricated side-coupled cavity chain of any appreciable length studied so far. The results of the study on this model showed that the predictions of the equivalent circuit analysis for $\pi/2$ mode structures were verified in all cases where direct experimental tests were feasible; an economical and practical method of tank fabrication was developed; and tuning techniques adaptable to the mass production of long tanks were devised. Final results of the low power tuning indicate that the tank has a resonant frequency of 804.910 MHz for the $\pi/2$ mode, a stop band of 19.2 kHz, a shunt impedance ZT^2 of 28.9 MΩ/m, and a maximum electric field variation of ±1.2% within the tank. The phase shift from one end to the other was essentially zero. (B.G.D.)

11834 (LA-3609, pp 176-82) HIGH FIELD MEASUREMENTS AT 200 MHz IN CONVENTIONAL PROTON LINEAR ACCELERATOR GEOMETRIES AT 5, 50, AND 130 MeV. Owen, C. W.; Radmer, C. A.; Young, D. E. (Midwestern Universities Research Association, Stoughton, Wis.).

Sparking and electron emission studies which were undertaken at MURA are reported. These were restricted to 200 MHz in linear accelerator cavities of the accelerator type with 500 μsec pulses and a 1% duty cycle. (B.G.D.)

11835 (LA-3609, pp 194-5) PROPERTIES OF DISC-LOADED CYLINDRICAL WAVEGUIDE PROPAGATING THE TM-02 MODE. Gallagher, W. J. (Applied Radiation Corp., Walnut Creek, Calif.).

Experimentally determined properties are presented of the TM-02 mode for the $2\pi/3$ longitudinal mode at the velocity of light, from which it would appear that this mode is significantly better for applications in accelerators with large output beam currents. (B.G.D.)

11836 (LA-3609, pp 196-7) ENERGY SPECTRUM IMPROVEMENT WITH THE HEM-II MODE. Gallagher, W. J. (Applied Radiation Corp., Walnut Creek, Calif.).

As a result of both theoretical and experimental work on the HEM-11 mode in the disc loaded waveguide it is apparent that it would be practical to use this structure for improvement of the energy spectrum of the electron linear accelerator. A proposed scheme is presented. The nearly parallel beam is transmitted through a dispersive isochronous momentum (energy) analyzer in such a manner that a parallel beam is formed, with the particles arranged transversely as a function of energy. If the bunches of the beam are synchronized with the longitudinal electric field of the HEM-II mode of the waveguide particles passing down the axis will be unaffected while off-axis particles will be accelerated (or retarded) proportionally to their displacement. Adjustment of the power level will form the emerging beam into a nearly monoenergetic slit or ribbon beam-which can then be focused onto the target by a quadrupole lens. Synthesis of an appropriate magnet system is not unique and further discussion is omitted. (auth)

11837 (LA-3609, pp 198-200) PHASE MEASUREMENT ALONG LINAC SECTIONS BY A RESONANT METHOD. Epsztein, B.; Tronc, D. (Compagnie Generale de Telegraphie Sans Fils, Orsay (France)).

During the construction of an electron linac, it is necessary to check the amplitude and phase of the rf field along the accelerating structure, in particular along the bunching section. It is then possible with the help of a computer to deduce the behavior of the electron beam during operation and by modifications of the structure, to optimize it. A method which relies on resonance perturbation technique was developed for this purpose. (B.G.D.)

11838 (LA-3609, pp 201-6) DESIGN EQUATIONS IN AN ALVAREZ-TYPE PROTON LINEAR ACCELERATOR. Carne, A. (Rutherford High Energy Lab., Chilton (England)); Lapostolle, P. M. (European Organization for Nuclear Research, Geneva (Switzerland)).

The accurate beam dynamics equations for an Alvarez-type linac can be used to give cell-by-cell design data. In particular, the cell lengths can be chosen such that a reference particle follows any phase law, in a tank where the mean E-field can be chosen arbitrarily, and where drift tube diameters and apertures may also vary. The S term for a particle in a gap is derived, and correction to both S and T in the design for a nonzero inner profile radius of curvature is discussed. Finally, the axial equations of motion in such a linac are stated. (auth)

11839 (LA-3609, pp 214-19) COUPLED MOTION IN LOW-ENERGY PROTON LINEAR ACCELERATORS. Ohnuma, S. (Yale Univ., New Haven, Conn. Dept. of Physics).

The coupling effect in proton linear accelerators was studied from a viewpoint which is based on the theory of the strong focusing system by Courant and Snyder. (B.G.D.)

11840 (LA-3609, pp 220-3) ON A UNIFORM CHARGE DENSITY OF A BEAM AND ITS PHASE-SPACE DISTRIBUTION. Ohnuma, S. (Yale Univ., New Haven, Conn. Dept. of Physics).

It is shown that, if a particle beam with a constant velocity and a constant current going through a linear focusing field has a uniform charge density everywhere, its particle distribution in the four-dimensional (transverse) phase space must be of the type assumed by Kapchinskij and Vladimirskij. All the particles are then distributed uniformly on the surface of a four-dimensional ellipsoid. Since the Fourier transform of the Kapchinskij-Vladimirskij distribution has the same form for accelerated and unaccelerated beams, it is expected that this is true for accelerated beams also provided one can ignore the effect of the transverse motion on the longitudinal motion. The method used is based on the Fourier transform of the particle distribution. (auth)

11841 (LA-3609, pp 233-6) NUMERICAL EXPERIMENT ON SPACE-CHARGE EFFECTS. Crandall, K. R. (Los Alamos Scientific Lab., N. Mex.).

A numerical experiment was devised to study the effects of space charge on the charge density, apparent emittance, and the beam profile of an axially symmetric, non-accelerating beam. All of the particles in the beam are assumed to have the same axial velocity $\dot{z}$, and the beam radius and the charge density are assumed to change slowly enough with respect to z so that the electric field due to space charge is entirely in the radial direction. (B.G.D.)

11842 (LA-3609, pp 243-4) SPACE CHARGE EFFECTS ON LONGITUDINAL MOTION IN PROTON LINACS. Benton, A.; Agritellis, C. (Brookhaven National Lab., Upton, N. Y.).

Several subroutines written for an existing BNL longitudinal motion program (LONMO) to include space charge effects. The basic program without space charge assumes all energy supplied to the particles by the rf field to be imparted at gap centers. The particles drift between centers at constant velocity and the phase changes are calculated without the Promé correction. Space charge effects are calculated by Lapostolle's formulas. The program calculates the center of gravity and second moment of the packet of charges and replaces it with a uniformly charged ellipsoid having the same center of gravity and second moment. The longitudinal axis of the ellipsoid is determined by the second moment; the axes in the transverse plane are specified as input to the program. Lapostolle supplies formulas for the energy change produced by space charge forces assuming the beam to be travelling in an infinitely long conducting cylinder while in a drift tube, and between two infinite parallel conducting plates while in a gap. These energies are added at the centers of the drift tubes and gaps respectively. In spaces between cavities, space charge contributions to energy are calculated by the same formulas as in drift tubes (merely changing the radius of the surrounding cylinder) and are added at intervals of $\beta\lambda$. (B.G.D.)

11843 (LA-3609, pp 245-9) PHASE-SPACE REPRESENTATION OF ABERRATIONS DUE TO LONGITUDINAL FIELDS IN QUADRUPOLES. Regenstreif, E.; Tanguy, P. (Rennes Univ. (France)).

In a certain number of practical arrangements, the length of a quadrupole used for focusing purposes may be comparable to its aperture. This can happen for instance at the exit of a short preaccelerating column or in the first focusing stages of a linear accelerator. The situation at the exit of a focusing system where the presence of a longitudinal field and the coupling due to aberrations may influence the beam behaviors represented in phase space. (auth)

11844 (LA-3609, pp 281-3) A NOTE ON TRANSVERSE BEAM INSTABILITIES IN MULTISECTION LINACS. Gluckstern, R. L. (Massachusetts Univ., Amherst); Nagle, D. E.; Visscher, W. M. (Los Alamos Scientific Lab., N. Mex.).

Preliminary operation of the Stanford Two-Mile Electron Accelerator has uncovered an unexpected transverse beam instability at a beam current below the design value. Various tests of the dependence of this effect on the pulse length, section length, beam current, and transverse focusing forces indicate that it is a coop-

erative phenomenon between transverse field oscillations in the various sections. A model was constructed for this beam blowup in the absence of large focusing forces, similar to those of Panofsky and of Sessler. The e-folding factor was estimated in terms of the starting current for runaway transverse oscillations in the first section. (auth)

11845 (LA-3609, pp 284-93) SIMPLE MODELS FOR BEAM-BLOWUP. Visscher, William M. (Los Alamos Scientific Lab., N. Mex.).

A chain of independent cylindrical cavities is a simple model for a linac and is the one which is considered. The normal-mode fields are described in detail, as is their interaction with an off-axis beam, and the resulting equation for beam deflection is displayed. The magnitude of the coefficient in this equation has a simple physical interpretation; namely, it is the electrostatic force attracting the bunch to its image induced in the wall of the accelerating tube. A discussion of deflection caused by cooperative buildup of the transverse fields by the beam bunches in a more general linac model is presented. An equivalent circuit description of a chain of cavities with linear coupling to nearest neighbors is worked out. The relations between the eigenvectors and eigenvalues of this system and the parameters of the bunched off-axis beam which are relevant to beam-blowup are discussed, as is the section-to-section variation in the normal modes which is consistent with coherent transverse-field buildup. (B.G.D.)

11846 (LA-3609, pp 294-302) BEAM LOADING EFFECTS IN STANDING WAVE LINACS. Nishikawa, T. (Tokyo Univ. (Japan)).

A brief review of beam loading effects in standing-wave linacs are described in terms of the microwave cavity theory (normal mode analysis of standing-wave linacs). (B.G.D.)

11847 (LA-3609, pp 303-31) OPTIMIZATION CRITERIA FOR STANDING WAVE TRANSVERSE MAGNETIC DEFLECTION CAVITIES. Haimson, Jacob (Massachusetts Inst. of Tech., Cambridge).

The use of standing-wave transverse magnetic deflection cavities as a prebuncher for linear accelerators, in order to achieve narrow energy spectra, is discussed. Topics included are microwave characteristics, beam deflection, and aberration calculations. (B.G.D.)

11848 (LA-3609, pp 332-6) TRANSIENTS IN ELECTRON LINACS. Epsztein, B.; Mangin, J. P. (Compagnie Generale de Telegraphie Sans Fil, Orsay (France)).

A number of physics studies require short pulses and high peak currents from electron linacs. The duration of these pulses can be much shorter than the filling time of the accelerator, in which case the operation cannot reach a steady state. Hence, it is necessary to develop a theory valid for such conditions. Leiss and Schrack, in particular have made an exhaustive analysis of this case. The main result of this study was a large increase of the beam-loading during the initial period of the beam pulse (about ten rf cycles) with respect to what would be computed in a conventional manner, disregarding the dispersion of the wave guide. A study was initiated with two main objects in mind: First, to get a better physical understanding of the phenomenon and its causes since the mathematical intricacy of Leiss' analysis did not allow an intuitive appraisal of the situation. Second, to obtain approximate analytic expressions for the beam loading in order to avoid the use of computers and be able to appreciate rapidly the influence for each parameter. The unexpected result was that this study did not show any trace of the extra beam loading discovered by Leiss, in spite of the fact that most initial assumptions were identical for both cases. Instead, our result is very close to the one obtained in the more naive approach neglecting dispersion effects. Details of this analysis, followed by a discussion on the reasons for the discrepancy are presented. (auth)

11849 (LA-3609, pp 337-43) TRANSIENT WAVE PROPAGATION IN LINEAR ACCELERATORS. Abraham, J. (Argonne National Lab., Ill.).

The determination of the velocity with which energy propagates in a cavity is discussed from observations made on the 50 MeV proton linac (Alvarez structure) at Argonne National Laboratory. For the purpose of analysis, it is assumed that the steady-state condition obtains when the amplitudes of the forward and backward traveling waves are equal and, furthermore, that all transients can be explained in terms of these waves. Specifically, when a transient occurs, the forward and backward wave are unequal and the envelope of the disturbance is the output of a detector. (B.G.D.)

11850 (LA-3609, pp 344-54) THE DUOPLASMATRON SOURCE FOR THE CERN-PS LINAC. Vosicki, B.; Buzic, M.; Cheretakis, A. (European Organization for Nuclear Research, Geneva (Switzerland)).

In order to improve the performance of the CERN-PS, the development of the DP ion source and associated high gradient column was undertaken. The conception, construction of the DP, and the results obtained during the first few months of operation are described. (auth)

11851 (LA-3609, pp 355-64) THE NEW 500 keV SINGLE-GAP PRE-INJECTOR TUBE FOR THE CERN PROTON SYNCHROTRON LINAC. Huguenin, J.; Dubois, R.; Visconti, G.; El-Bez, R. (European Organization for Nuclear Research, Geneva (Switzerland)).

The conception, testing, and operational behavior of single or two-gap (adjustable from 7.5 to 12.5 cm) high gradient (~45 to 75 kV/cm) dc pre-injector accelerating tube for the CERN proton synchrotron are described. (B.G.D.)

11852 (LA-3609, pp 365-70) INITIAL TESTS OF THE MURA HIGH GRADIENT COLUMN. Curtis, C. D.; Lee, G. M.; Fasolo, J. A. (Midwestern Universities Research Association, Stoughton, Wis.).

The MURA high gradient column has been voltage tested to 600 kV with a brief conditioning time. Current drawn from the electrodes appears negligible. In tests for a few days with an ion source in operation, preliminary data on accelerated beam quality indicate quite small aberrations due to a focusing lens introduced following the source. Some indicated increase in emittance of the accelerated beam requires more careful measurement for confirmation. The column with beam has been operated thus far only to 370 kV with beam currents below 60 mA. Limitations have been imposed by inadequate pumping speed of an experimental titanium sublimation plus ion pumping system. Construction details of the column are shown in drawings and photographs. Also beam quality is indicated by fluorescent plate photographs. (auth)

11853 (LA-3609, pp 371-82) DUOPLASMATRON SOURCE PERFORMANCE AT MURA. Fasolo, J. A.; Curtis, C. D.; Lee, G. M. (Midwestern Universities Research Association, Stoughton, Wis.).

A duoplasmatron with an expanded plasma front and a Pierce-electrode extraction geometry has been under development at MURA since September, 1965. Modifications of expansion cup, magnetic aperture, plasma-defining aperture, intermediate electrode, and extraction geometries to increase beam current and improve beam quality are reviewed. A source point correction to emittance estimates is derived. Emittance estimates, beam characteristic curves, and some results of mass analysis are presented and discussed. Results of a constant perveance experiment are given. A transition region in the beam characteristic curves is related to plasma boundary shape and beam quality. A magnetic field shaping experiment is discussed. Results of a bench test of the preaccelerator extractor and focus electrode geometry are presented. (auth)

11854 (LA-3609, pp 390-3) EXPECTATIONS AND POSSIBLE INTERPRETATION OF ION SOURCE BEHAVIOR. Curtis, C. D. (Midwestern Universities Research Association, Stoughton, Wis.).

The question as to whether an ultimate emittance or phase space density for some given beam current is being approached is discussed in relation to recent progress in ion source performance. A related question is also discussed having to do with what change in emittance should be expected from a well-behaved ion source when its beam current is increased. (B.G.D.)

11855 (LA-3609, pp 394) A NOTE ON SOME EMITTANCE MEASUREMENTS. Wroe, Harold (Rutherford High Energy Lab., Chilton (England)).

Some preliminary results are described of an experiment in which an ion beam, from a duoplasmatron with geometry identical to the Brookhaven source, is accelerated to an energy of several hundred kV across a single gap. (B.G.D.)

11856 (LA-3609, pp 395-7) A 100 mA ION BEAM WITH A LARGE BRIGHTNESS. Bernard, P.; Faure, J.; Vienet, R. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

A description is presented of a 350 keV preaccelerator used as a model for the construction of the 750 keV preinjector of the Saturne new injection line. The description includes ion source, beam extraction system, focusing lenses, and acceleration tubes. (B.G.D.)

11857 (LA-3609, pp 398-402) PIERCE GEOMETRY: AN ACCELERATING COLUMN DESIGN. Emigh, C. Robert (Los Alamos Scientific Lab., N. Mex.).

The popular trend in today's design of accelerating columns is to make the field gradient near the extraction area as large as possible. The argument has been that if the proton beam energy can be brought up to the accelerator injection level in a very short distance, space charge has little time in which to act to increase

the effective emittance by warping the emittance pattern. Support for this argument has come from the success of recently tested short columns in producing proton beams with low normalized emittances, in the region of 0.05 cm-milliradian. It is generally accepted that only the extraction system of Pierce is without aberrations. To emphasize these essential features of the Pierce extraction—coaxial flow, zero angular momentum, and a uniform density distribution—a derivation based on a zero effective emittance pattern throughout the acceleration is presented. Thus the recent successes in generating low emittance beams are probably the result of the Pierce-like geometries used by the column designer to implement his high gradient criteria rather than a result of the high gradient itself. The high gradient has the advantage of reducing the beam diameter to a manageable size for a given current. A simple integral equation for the field required outside the beam to support the Pierce geometry is derived. The equation is exact, based only on the 4/3 power law potential gradient at the beam boundary and on Laplace's equation outside the beam. (auth)

11858 (LA-3609, pp 403-9) DESIGN OF A 20 MeV PROTON LINEAR ACCELERATOR, NEW INJECTOR FOR SATURNE. Prome, M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

In order to increase the number of particles accelerated by the 3 BeV proton synchrotron SATURNE, it has been decided to replace its 3.6 MeV Van de Graaff injector by a 20 MeV linear accelerator. This accelerator is now being built. The main ideas which led to the design of this machine, and how the geometrical dimensions were chosen are discussed. (auth)

11859 (LA-3609, pp 410-16) STATUS REPORT OF THE ORSAY LINAC. Brunet, P.; Burnod, L. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire).

The purposes for extending the performance (energy and current) of the linear accelerator at Orsay are discussed. The modifications to the existing linac are briefly summarized. (B.G.D.)

11860 (LA-3609, pp 417-25) THE NEW HIGH DUTY CYCLE HIGH CURRENT 600-MeV ELECTRON-POSITRON LINEAR ACCELERATOR OF SACLAY. Sokolovsky, A. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

The facilities of the new Saclay linear accelerator are described. The present status of its schedule is outlined. (B.G.D.)

11861 (LA-3609, pp 426-34) SOME CHARACTERISTIC PROBLEMS OF THE NEW HIGH DUTY CYCLE SACLAY ELECTRON LINAC. Leboutet, H.; Azam, G.; Bensussan, R.; Delmon, Blaise; Soffer, Mangin.

The characteristic problems of the new high duty cycle Saclay electron linac are briefly outlined. The problems include choice of optimum rf power and length, mechanical, cooling, and beam blowup problems concerned with the sections, positron generator, beam injection, and stability. (B.G.D.)

11862 (LA-3609, pp 435-8) POSITRON ACCELERATION IN THE FRASCATI 450-MeV LINEAR ACCELERATOR. Amman, F.; Andreani, R. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati); Haimson, J.; Nunan, C. (Varian Associates, Palo Alto, Calif.).

A progress report is presented on the first results of beam testing on the Frascati 450 MeV positron linear accelerator. (B.G.D.)

11863 (LA-3609, pp 439-48) RESULTS ON SOME EUROPEAN LINEAR ACCELERATORS. Azam, G.; Milcamps, J. (Compagnie Generale de Telegraphie Sans Fil, Orsay (France)).

The characteristics and performance of two European linear accelerators, Euratom linear electron accelerator and 300 MeV linear accelerator of Mainz (Germany), are discussed. (B.G.D.)

11864 (LA-3609, pp 449-56) 805 MHz RF POWER SOURCES. Nagle, D. E. (Los Alamos Scientific Lab., N. Mex.).

The LASL linac design calls for a 201.25 MHz Alvarez linac followed by waveguide tanks operating at 805 MHz. There are to be 45 amplifiers with 1 MW output at 805 MHz. The amplifiers are described, with emphasis on the final power amplifier tube. (B.G.D.)

11865 (LA-3609, pp 471-8) COMPUTER CONTROL OF THE LAMPF ACCELERATOR. Putnam, T. M.; Butler, H. S.; Smith, J. J. (Los Alamos Scientific Lab., N. Mex.).

A data acquisition and control system for the 800-MeV proton linear accelerator for the proposed Los Alamos Meson Physics Facility has been designed in depth on the premise that an on-line digital computer affords the best means of maintaining operational control over the machine. The three basic functions of any control system—data acquisition, display, and control—which were implemented with the aid of a computer are described. The system as presently designed has the capability for sampling any one of 63 analog or binary data channels at any of the 55 modules in the facility (or one channel from all 55 modules simultaneously). Similarly, the system can adjust any one of the 63 control channels at any or all modules. In addition, the system can select remotely any two video channels (of a possible 31 at each module) for display in the central control room. As an example of the speed of the system, it can sample and store in the computer's memory 10 binary status indications from each of the 55 modules in less than 250 microseconds. All information regarding the operational status of the accelerator is available to the operator on just two partial racks. The ability to adjust any control channel in the facility is provided on the same two racks. The system, which incorporates a versatile display scope, allows the operator to execute such varied and sophisticated tasks as steering the beam to compensate for misalignments of the accelerator, making phase space plots of the beam, and performing parametric studies of the effect of any control channel—all on-line. The concepts and operational procedures embodied in the LAMPF computer control system will be tested and evaluated in a series of experiments referred to as the mockup program. The status of the hardware to be used in this program is described. (auth)

11866 (LA-3609, pp 483-90) DIGITAL CONTROL OF THE BEVATRON-INJECTOR INFLECTION TRAJECTORY. Allison, Robert W. Jr.; Belshe, Robert A.; Evans, Don M.; Hartwig, Edward C.; Lancaster, Henry D.; Machen, Donald R.; Richter, Robert M.; Zajec, Emery (California Univ., Berkeley. Lawrence Radiation Lab.).

To minimize pickup jitter in the Bevatron, and to evaluate the digital control system proposed for the 200-BeV accelerator, a digital control on the Bevatron achromatic inflector was installed. A PDP-5 computer with interfacing provides 40 monitoring and 20 control channels. The interface communicates with the computer and the inflector system through time-division multiplexers. The system provides both automatic and manual control of the inflector deflection and focusing elements. Using the analog monitoring developed for beam control, the operating parameters of the inflection system were adjusted for maximum charge survival in the Bevatron. As a result, the injection efficiency increased by 30%. The beam position (at each monitoring station) was also set by using closed-loop digital control. Resonant induction electrodes are used to detect the center of gravity of the beam. Three-pulse convergence was obtained, with a resolution of ±0.1 mm. (auth)

11867 (LA-3609, pp 491-3) STANFORD'S SUPERCONDUCTING ACCELERATOR PROGRAM. Smith, T. I.; Schwettman, H. A.; Fairbank, W. M.; Wilson, P. B. (Stanford Univ., Calif. Dept. of Physics).

The progress of Stanford's University's program to develop a useful superconducting electron linear accelerator is discussed. A description of the superconducting linac program and details of the ten foot test section are presented. (B.G.D.)

11868 (LA-3609, pp 494-6) PLANS FOR A SUPERCONDUCTING C. W. ELECTRON LINAC AT THE UNIVERSITY OF ILLINOIS. Hanson, A. O.; Jamnik, D.; Robinson, C. S.; Rogers, C. L. (Illinois Univ., Urbana. Dept. of Physics).

A program to build an L band section, 15 feet long, which might be operated at 30 MeV and a CW accelerator of 400 MeV is discussed. The construction of a nitrogen shielded cryostat about 4 feet long into which can be mounted an L band section 3 wavelengths long, surrounded by liquid helium at temperatures down to 1.8°K, is described. (B.G.D.)

11869 (LA-3609, pp 497-8) STATUS REPORT ON THE FEASIBILITY STUDY FOR A SUPERCONDUCTING LINEAR ACCELERATOR FOR PROTONS. Citron, A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik).

A study into the possibility of designing a superconducting proton linear accelerator operating CW and giving between 10 and 100 μA of protons is discussed. (B.G.D.)

11870 (LA-3609, pp 499-501) PREPARATION AND PERFORMANCE OF SUPERCONDUCTING CAVITIES. Flecher, P.; Halbritter, J.; Hietschold, R.; Hofmann, K. (Technische Hochschule, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik).

Three methods were used to produce superconducting cavities: electroplating, electroless deposition, and evaporation. The Q-value of the structures was measured using the decrement method. (B.G.D.)

11871 (LA-3609, pp 502-7) INVESTIGATION OF THE SLOTTED IRIS STRUCTURE WITH DRIFT TUBES. Eschelbacher, H.; Schopper, H. (Technische Hochschule, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik).

In order to obtain a systematic optimization of the slotted iris

structure measurements were performed with demountable models consisting of three or six cells. The measurements were resonance frequencies for all modes, Q-values for all modes, and effective shunt impedance for the π-mode. The influence of geometrical parameters was investigated for different cell lengths. (B.G.D.)

11872 (LA–3609, pp 508-10) A ONE MeV/NUCLEON HEAVY ION LINEAR ACCELERATOR. Bieth, C.; Cabrespine, A.; Goldstein, Ch., Bosser, J.; Arianer, J.

The ion source, accelerating cavity, and focusing system of the heavy ion linear accelerator which is being constructed at Orsay are discussed. (B.G.D.)

11873 (ORNL-TM–1746) PROPOSAL TO ACQUIRE A DATA-HANDLING SYSTEM FOR THE OAK RIDGE ELECTRON LINEAR ACCELERATOR. Burrus, W. R.; Harvey, J. A.; Maienschein, F. C.; Reynolds, J. W.; Sullivan, J. G. (Oak Ridge National Lab., Tenn.). Jan. 17, 1967. Contract W-7405-eng-26. 29p. Dep. mn, CFSTI $3.00 cy, $0.65 mn.

This proposal outlines the computer system and associated digital equipment planned for data handling at the Oak Ridge Electron Linear Accelerator (ORELA). In order that ORELA fulfill its experimental objectives, including that of being a major source of neutron cross-section information for the fast breeder reactor program, the data-handling system is essential for the high data-accumulation rates and masses of data to be analyzed. The system is divided into three distinct parts corresponding to stages of data handling: acquisition, immediate analysis, and final analysis. Justification is given for this division and alternate systems are considered. The system is to be delivered in three parts. The first part is expected in February 1968, three months prior to completion of the acceptance tests of the accelerator; the second part is to be delivered in February 1969; the third part is to be delivered in February 1970. A portion of the system will be shared with the other large ORNL nuclear physics facilities (the Isochronous Cyclotron and High Voltage Laboratory). (auth)

11874 (SLAC-PUB–240) DESIGN CONSIDERATIONS FOR HIGH ENERGY ELECTRON–POSITRON STORAGE RINGS. Richter, B. (Stanford Linear Accelerator Center, Stanford Univ., Calif.). Nov. 1966. Contract AT(04-3)-515. 32p. (CONF-660939–2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Symposium on Electron and Positron Storage Rings, Saclay, France.

After a discussion on the importance of high energy electron-positron storage rings on progress in elementary particle physics, two design considerations are evaluated. The considerations are what luminosity (reaction rate per unit cross section) is required and what should be the maximum energy of the ring. (B.G.D.)

11875 (ORNL-tr–1469) EXTRACTION OF A BEAM OF HEAVY IONS ACCELERATED IN A STELLAR FIELD CYCLOTRON BY STRIPPING. Oganessian, Youri; Cabrespine, Andre; Martin, Emile; Sergolle, Henri; Langlois, Denise; Poffe, Nina. Translated for Oak Ridge National Lab., Tenn., from Compt. Rend., Ser. A and B, 262: 1359-62(1966). 6p. Dep. mn. JCL $1.10 fs, $0.80 mf.

A new device for the extraction of a beam, which permits a 100% yield, was investigated on the focusing sector and heavy ion cyclotron of Orsay. This process is applicable to incompletely ionized multicharged heavy ions and permits an extraction at variable energy as a function of the stripping radius. The internal beam of particles accelerated by a cyclotron in general is extracted by perturbing the radius of curvature of the peripheral path by an additional electric field (electrostatic deflection). The principle of the extraction device investigated consists of modifying the charge of the accelerated particle, which results in a sharp variation of the radius of curvature of its path. (B.G.D.)

11876 CURRENT STABILIZATION SYSTEM FOR ELECTROMAGNET POWER SUPPLY. Voronin, V. S.; Semenov, S. S. Tr. Fiz. Inst., Akad. Nauk SSSR, 34: 246-55(1966). (In Russian).

A constant-current generator is used to feed the coils of an electromagnet used for start-up of a 30-MeV, radial-sector synchrocyclotron. In order to stabilize the constant current and to suppress the voltage pulsations at the generator exit to 0.03%, a set of 6 regulating tubes are connected in parallel with the generator excitation windings, and another set of 18 regulating tubes are placed in parallel with the load. A voltage to suppress pulsations and stabilize the constant current is fed from the exit of the constant-current amplifier to the control circuits of the regulating tubes. The amplifier uses parallel operation of a narrow-band, constant-current amplifier with low zero drift and a wide-band, alternating-current amplifier. The amplifier circuit stabilizes the operation of the regulating tubes and the smooth coupling of the narrow-band and the wide-band frequency characteristics. With this stabilization circuit, the constant-current generator can be used as a source of highly stable current or as a source of highly stable voltage. (TTT)

11877 CALCULATIONS OF TRI-CIRCUIT BAND FILTERS. Voronin, V. S.; Semenov, S. S. Tr. Fiz. Inst., Akad. Nauk SSSR, 34: 241-5(1966). (In Russian).

In a number of cases it is required that band filters operate without a converter between the unequal resistance on the ends. A three-circuit band filter can be utilized in practice as a four-pole, converter unit in heavy-duty, wide-band, high-frequency amplifiers. The three-circuit band filter should be designed to obtain a maximum transfer of power from the anode of the previous cascade to the cathode of the following cascade with minimum distortion of the frequency characteristics. A simple expression is derived for the limiting frequencies of the filter transmission band. If the allowable frequency variation is given, it is possible to calculate the values of the capacities and inductances in both circuits of the symmetrical, three-circuit filter. The computational method was used in designing the hf system of a synchrocyclotron. (TTT)

11878 A ROTATING COLLIMATOR WITH ADJUSTABLE FIELD SIZES FOR THE 22.5 MeV BETATRON. Le Van, H.; Sassoon, H. (Univ. of Illinois, Chicago). Int. J. Appl. Radiat. Isotop., 18: 85-6(Jan. 1967).

A new collimator designed to fit the x-ray port of the 22.5-MeV betatron is described. The system is composed of two inserts, the outer of which is attached permanently to the betatron port, and serves as a collimator for circular fields. The inner insert has a rectangular aperture and is mounted when rectangular field sizes are needed; it can be rotated 360° about the beam axis and can give various field sizes when the appropriate lucite cones are attached. The intensity is maximum along a center line perpendicular to the front of the betatron magnet. The output at 22.5 MeV is about 125 rad/min. The system is particularly useful in the treatment of cancer patients. (UK)

11879 INDUCED RADIOACTIVITY IN THE COLLIMATOR SYSTEM OF A 31 MeV BROWN BOVERI BETATRON. Stroemme, Aksel (Norwegian Radium Hospital, Oslo). Phys. Med. Biol., 12: 25-8(Jan. 1967).

The doses received by the hands of operators who have to handle the removable gamma-ray collimator were measured and found not to exceed 4 mR/day, so long as care is taken not to touch the most radioactive part near to the target. (UK)

11880 PHYSICAL ASPECTS OF THE DEUTERON AND HELIUM NUCLEI BEAMS FROM THE M.R.C. CYCLOTRON. Bewley, D. K.; Field, S. B.; Parnell, C. J. (Hammersmith Hospital, London). Phys. Med. Biol., 12: 1-12(Jan. 1967).

Irradiation conditions, dosimetry and measurements of beam energy are described for beams of deuterons and helium nuclei from the Medical Research Council Cyclotron. It is necessary to use very thin samples, and these are placed on a revolving wheel so that they are moved across a narrow beam emerging from the cyclotron. Using the track segment method it is possible to obtain LET_∞ values from 5.5 to 20 keV/μ with deuterons, and from 26 to 100 keV/μ with helium nuclei. Beam energies were measured by several methods, the mean values being 16.7 and 32.8 MeV inside the machine for deuterons and helium nuclei respectively. A Faraday cup and a calorimeter were used to check the accuracy of the monitor chamber, and satisfactory agreement was obtained between theory and experiment. (auth)

11881 A VOLTAGE AND CURRENT REGULATOR FOR 1-MV VAN DE GRAAFF GENERATOR. Jakschik, J. (Freie Univ., Berlin). Nucl. Instrum. Methods, 47: 265-8(1967). (In German).

Design and performance of a simple voltage and electron-current regulator for an 1 MV-Van de Graaff-generator is described. Each of the two circuits of a slow integral and a faster proportional regulation unit. The long-time-voltage-stability is ±2–3%. The current-stability is about ±1%. (auth)

11882 METHOD OF HIGH-RESOLUTION DATA ACQUISITION. Seibel, F. T.; Roberson, N. R.; Bilpuch, E. G.; Newson, H. W. (Duke Univ., Durham, N. C.). Nucl. Instrum. Methods, 47: 244-8(1967).

A system for modulating the energy of a Van de Graaff accelerator, while also correcting for the time-dependent fluctuations, was developed allowing cross-section data to be taken with a multichannel analyzer. As much as 20 keV can be taken at one time. Combined with a windowless gas target, data were taken with 250 eV resolution. (auth)

11883 PHASE STABILIZED BEAM PULSING SYSTEM. Adelberger, E. (California Inst. of Tech., Pasadena). Nucl. Instrum. Methods, 47: 327-8(1967).

A simple phase stabilizer was developed for klystron-type bunchers used in nanosecond beam-pulsing systems. It improves the bunching efficiency by compensating for time-dependent variations in the injection energy and produces greatly increased average currents. The phase detection principle has applications in accurate measurements of beam energies. (auth)

11884 AIRBORNE RADIOACTIVITY PRODUCED AT HIGH-ENERGY ACCELERATORS. Rindi, A.; Charalambus, S. (CERN, Geneva). Nucl. Instrum. Methods, 47: 227-32(1967).

During accelerator operation, radioactivity is produced by the interaction of primary and secondary particles with the atmospheric air in the machine halls. The types of radionuclides produced and their specific activity in the air were measured and compared to calculated values for the two CERN accelerators. Maximum permissible concentration of the identified isotopes was calculated and used to compare with the measurements to evaluate the hazard. (auth)

11885 A PRECISION ENERGY CALIBRATION FOR THE CAMBRIDGE ELECTRON ACCELERATOR. Winick, H. (Harvard Univ., Cambridge, Mass.). J. Nucl. Energy: Pt. C, 8: 635-44(Nov.-Dec. 1966).

The external electron beam of the CEA was focused vertically and bent upward by a 6-ft deflecting magnet. The deflected and undeflected beams were allowed to drift 20 ft through a vacuum pipe producing a separation of about 32 in. Accurate measurements of this separation were made by surveying the spots produced by the beams on glass slides. Combining this measurement of angular deflexion with a precise mapping of the field of the deflecting magnet yielded a calibration of the energy of the synchrotron at nominal energies of 1, 2, 3, 4, 5 and 6 GeV. These measurements show that the peak synchrotron energy is linear with peak synchrotron magnet current. Expressed in terms of the synchrotron magnet dc current (in terms of millivolts on the shunt), the result 62.73 mV/GeV was obtained. This result is accurate to better than ±0.2%. It was found that careful control of hysteresis and eddy current effects in the deflecting magnet were essential in obtaining reproducible magnetic field plots. (auth)

11886 CONTRIBUTION TO NONLINEAR THEORY OF INSTABILITY OF AN ELECTRON BEAM IN A SYSTEM WITH ELECTRODES. Shapiro, V. D.; Shevchenko, V. I. Zh. Eksp. Teor. Fiz., 52: 144-53(Jan. 1967). (In Russian).

A nonlinear theory of the instability of a monoenergetic electron beam in a system with electrodes is considered for the case of small supercriticality. It is shown that if $u_0 > 0$ then on passage through the boundary of the stability zone the energy of the oscillations excited in the beam increases discontinuously to a magnitude comparable to the initial beam energy. For such oscillation amplitudes intersection of trajectories in the beam may be possible and multibeam motions may arise. (auth)

11887 NONLINEAR LONGITUDINAL WAVES IN ELECTRON BEAMS. Gladun, A. D.; Leiman, V. G. Zh. Eksp. Teor. Fiz., 52: 154-7(Jan. 1967). (In Russian).

Exact solutions are obtained which describe stationary longitudinal waves in nonrelativistic electron beams with an external magnetic field. (auth)

11888 POLARIZED PROTON TARGETS AT CEA-CERN FOR HIGH ENERGY PHYSICS. Borghini, M. (CERN, Geneva). Bull. Inform. Sci. Tech. (Paris), No. 106, 17-34(July-Aug. 1966). (In French).

The importance and the development of the recent polarized proton target technique is shown, and the principle of their polarization is related briefly. Two targets are then described, which were developed and built by the solid physics and magnetic resonance division (Physics Department) at Saclay, and used at the C.E.R.N. in high energy physics experiments. (auth)

11889 CYLINDRICAL ELECTRON LENSES. II. Hawkes, P. W. (Cavendish Lab., Cambridge, Eng.). Optik, 24: 95-107 (1966-7).

Formulas for cylindrical electron lenses are derived and compared with those obtained by Leitner, Shtepa, Laudet, and Strashkevich. A critical examination is made of various other formulations in relation to the expressions derived here. The formulas derived by Laudet proved to be incomplete, in that the boundary conditions applied in the course of integration correspond to a stigmatic system of cylindrical lenses. It is concluded from this study of the aberrations of cylindrical lenses that it is necessary to take great care in setting the boundary conditions for any particular situation. It is important to distinguish between the Gaussian rays which are appropriate in systems with and without an aperture, to use the hybrid h-ray in the former situation, and express the aberrations in terms of the slope of the rays at the object instead of their position at the aperture. (BBB)

11890 INVESTIGATION OF PLANE POLARIZATION OF THE BREHMSSTRAHLUNG FROM THE 15 MeV BETATRON. Martynov, E. P.; Serebrennikov, Yu. I. (Leningrad Polytechnic Inst.). Yadern. Fiz., 4: 1183-6(Dec. 1966). (In Russian).

Linear polarized γ quanta are obtained by means of the trip-out of the betatron electron beam on the thin (7 μ) Al target and the selection of γ quanta emitted at the angle $\theta_0 = mc^2/E$ to the electron beam. The degree of polarization of γ quanta and its energy dependence is calculated from the photoproton azimuthal angular distribution from the reaction $D(\gamma,p)n$. (auth)

11891 ELECTROSTATIC TWO-TUBE LENS IN THE LIMITING CASE OF HIGH LENS STRENGTH. Typke, D. (Technische Hochschule, Darmstadt, Ger.). Optik, 24: 1-9(1966-7). (In German).

A very intense electrostatic electron lens consists of a symmetrical rotational field where the electrons are strongly decelerated or accelerated. In two-tube lenses of high strength the electron paths oscillate about the axis, causing development of real intermediate images internally within the lens. The same phenomenon is also observed in high strength electrostatic single lenses and with immersion lenses with other configurations. The asymptotic focal length depends largely on the electron velocity. Because of this, lenses of this type are very suitable for velocity analysis or as electron filters. Definite calculations for high strength two tube lenses are unavailable, except for relatively low strength lenses where the potentials of both tubes, as compared to the cathode, vary within the range $\frac{1}{500} \leq \phi_2/\phi_1 \leq 500$. In this study the properties of lenses outside of this range are studied. In the limiting case one of the two-tube potentials nullifies the cathode potential taken as zero. The potential drop of an immersion lens that includes the intensity range $0 < \phi_2/\phi_1 < \infty$ is based on an arctan function, so that in this case the path equation can be solved with tabulated functions. However, this potential drop cannot be realized with a simple electrode arrangement. The electrode form for the axial potential observed as a tan k function can be more easily realized. The solutions are applicable in the ranges $\phi_2/\phi_1 > 100$ and $\phi_2/\phi_1 < 10^{-2}$. The cardinal elements and the zeros of the electron paths are determined. The asymptotic values for spherical aberration are calculated, too. (BBB)

11892 GAUSSIAN DIOPTRICS OF LIMITED NONROUND ELECTRON LENSES. Rose, H. (Technische Hochschule, Darmstadt, Ger.). Optik, 24: 108-21(1966-7). (In German).

Every electron optical image formed by limited, nonround lenses can be described in Gaussian approximation by cardinal elements. The cardinal elements are established by the asymptotes of the cardinal paths. There are 16 cardinal elements in all, but only 10 are independent. For each objective plane there are two astigmatic image planes which may be real or virtual. The two image lines are perpendicular to each other, but generally the corresponding objective lines are not. The object and image lines rotate about the z-axis when the object plane is shifted, so that the image plane interval is changed. Generally, there is no position of the object plane where it disappears. Because of this, usually there is no stigmatic image point. If the cardinal elements are sufficient for an additional postulate then the two astigmatic image planes coincide in a particular objective plane and produce a stigmatic image. By additional postulates the stigmatic image is also forced for two or all objective positions. Each image-forming system has 4 focal distances (they can be infinitely large only in pairs, one on the objective side and one on the image side). If two focal distances increase beyond all limits then the system is like a semitelescopic cylindrical lens. If all 4 focal distances are limitlessly large, then it is a complete telescopic system. The graphic determination of the astigmatic image is feasible, knowing the cardinal elements, but it is very complicated. The usual Gaussian construction can be applied only to systems where the path equations can be balanced out. The cardinal elements of a special magnetic cylinder lens are calculated. (BBB)

11893 REMOVAL OF NONLINEAR EFFECTS IN DEFLECTING MAGNETS. Issinskii, I. B.; Kotov, V. I.; Kulakova, E. M.; Myznikov, K. P.; Smirnova, L. A. (Joint Inst. for Nuclear Research, Moscow). Nucl. Instrum. Methods, 48: 147-50(Feb. 11, 1967).

The analysis of the influence of second-order terms in the magnetic field expansion upon the motion of charged particles in deflecting magnets is presented. It was indicated that at large values of the field-index n nonlinear effects at exit angles result in essential corrections which should be taken into account in the calculations of particle transport systems. The dependence was found of the magnetic field upon the radius, which will make it possible to minimize nonlinear effects for most of the cases taking place in practice. (auth)

11894 PROBABILITY DISTRIBUTION OF THE EQUILIBRIUM ORBIT DISPLACEMENT IN AN AG SYNCHROTRON DUE TO

RANDOM ERRORS IN MAGNET LOCATIONS. Thiebaux, M. L. Jr. (Univ. of Massachusetts, Amherst. Brookhaven National Lab., Upton, N. Y.). Nucl. Instrum. Methods, 48: 61-3 (Feb. 11, 1967).

The probability distributions of certain random variables chosen to estimate the deviation of the equilibrium orbit from its ideal position due to random magnet location errors in an alternating-gradient synchrotron are investigated. The distributions are determined in a unified form which lumps the details of orbit theory into two parameters. Initial steps are taken on the basis of orbit theory to express these parameters in terms of the matrices which correlate the random errors in magnet locations. (auth)

11895 COLLISION RINGS AT CERN. Lapostolle, P.; Martin, A. (CERN, Geneva). Bull. Inform. Sci. Tech. (Paris), No. 106, 3-15(July-Aug. 1966). (In French).

It is briefly explained why, if two beams of fast particles are directed one against another, much higher energies are brought into play then those available with present-day fixed target accelerators. Several questions which arise in the field of strong interactions at very high energy and from which information can be obtained by means of collision rings are reviewed. The theoretical and technical difficulties involved in the construction of such an apparatus are then examined, and the solutions adopted by the physicists and engineers of C.E.R.N. are presented. (auth)

11896 THE SCIENTIFIC PROGRAM FOR THE CEVIL AT ORSAY. Lefort, Marc (Faculte des Sciences, Orsay, France). Ind. At., 10: No. 11, 41-50(1966). (In French).

The chief performances and technical characteristics of the new variable energy cyclotron constructed in Orsay are briefly given. This machine is particularly designed to accelerate heavy ions and alpha particles. The principal experiments under way concern the issuance of the beam by thinning out of the ions and modification of their trajectories. Another field of activities envisaged is that of the production of new radioelements deficient in neutrons and of transuranian elements. Lastly, special emphasis will be laid on the experiments in nuclear chemistry being prepared for the purpose of studying the mechanism of reactions between complex nuclei: de-excitation of fusion nuclei with high angular velocities, transfers of nuclear matter, fission of intermediate nuclei. Two experiments are described in detail. (auth)

11897 ORSAY MULTIPARAMETRIC ANALYZER. Victor, Charles; Brun, Jean-Claude; Verroust, Gerard (Institut de Physique Nucleaire, Orsay, France). Ind. At., 10: No. 11, 59-65(1966). (In French).

The multiparametric analyzer with ordinator in line, the study of which was begun in 1961, has now been in service in the laboratory for the past 20 months. After a review of the principles underlying this achievement, the analyzer is briefly described, and then a first balance sheet of how it has worked out in practice is drawn. In conclusion, new work now in progress and future projects in this field are mentioned. (auth)

11898 BEAM DRIFT IN ION LINEAR ACCELERATORS WITH QUADRUPOLE FOCUSING BY ACCELERATING FIELD. Maltsev, A. P. At. Energ. (USSR), 21: 295-7(Oct. 1966). (In Russian).

Quadrupole focusing by accelerating fields in linear accelerators demands certain precision in the preparation and suspension of drift tubes. An error in the distribution of drift tubes in linear accelerators with quadrupole focusing may deform the h-f lenses. Experiments were carried out with a variation in quadrupole focusing in a system with two gaps in the accelerating period. In such a case an error with one lens produced lesser effects on the particle motion than in the case of a single gap but required a larger number of lenses. It was shown that with only a slight adjustment of the drift tube the deformation of the focusing field can be fitted to the corresponding shift of the h-f lenses. The evaluations show that the tolerance of an accelerator with quadrupole focusing by accelerating fields under ordinary conditions is identical to that of an accelerator with magnetic quadrupole focusing but the preparation of the drift tubes is simpler because the latter demand coil mounting, gradient fixing, and magnetic-optical axis adjustment. (R.V.J.)

11899 ORSAY VARIABLE ENERGY CYCLOTRON. Cabrespine, Andre (Institut de Physique Nucleaire, Orsay, France). Ind. At., 10: No. 11, 51-8(1966). (In French).

The Orsay variable energy cyclotron was developed to accelerate heavy ions in particular. A rapid description of this machine is given, bringing out its particular or original characteristics. This accelerator was constructed according to the most recent techniques and a great effort was made with a view to facilitating the setting of the magnetic field and the high fidelity frequencies. In a year, the energies obtained will be increased, thanks to the use of a linear injector. This installation will then be the most powerful heavy-ion accelerator in the world. (auth)

11900 VOLNOVODNYE SINKHROTRONY. (Synchrotron Waveguides). Vorobev, A. A.; Didenko, A. N.; Bezmaternykh, L. N.; Kovalenko, E. S.; Lisitsyn, A. I.; Morozov, B. N.; Potekhin, Yu. I.; Salivon, Yu. A. Moscow, Atomizdat, 1966. 102p.

Electrodynamic properties of various delaying systems used with synchrotron waveguides are analyzed and the influence of accelerated particles on synchrotron waveguide performance is discussed. A description is given of waveguides for a 10 MeV synchrotron. A comparison is made of the acceleration systems of the circular orbit synchrotron waveguides with the newer systems of high-energy synchrotron waveguides. The efficiency of waveguides used in cybernetic proton synchrotrons is estimated. (tr-auth)

11901 R.F. SEPARATOR (Engineering Materials). (Stanford Linear Accelerator Center, Stanford Univ., Calif.). (CAPE-1507).

22 drawings.

The rf separator is used in the Stanford Linear Accelerator to separate high-energy particles which are traveling in a cavity at different velocities. In the cavity in which a microwave is propagated, its modes are such that its transverse modes will react with particles traveling through the cavity at certain velocities, but not with others. This principle is used to separate particles. (For details see TID-4100 Suppl. 37) (F.S.)

11902 ACCELERATING TUBE FOR A BETATRON. Seki, Koshitaka (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-5120. Mar. 22, 1966. Filed Dec. 8, 1964.

In the accelerating tube proposed, an improvement is achieved in the support (or holder) of a target. At one part of the inside surface of the circular accelerating tube is installed, air-tight, an expansion and contraction body. On top of this body is fixed an arm-shaped rod, extending inward in the accelerating tube; a target for the electron beam irradiation is held at the top end of this rod. By expansion and contraction of the said body, the position (in the accelerating tube) of the target can thus be adjusted for the electron beam. (NSA of Japan)

11903 ACCELERATING TUBE FOR A BETATRON. Suematsu, Shigeru (to Hitachi Ltd.). Japanese Patent 1966-5118. Mar. 22, 1966. Filed Sept. 9, 1964.

An improved accelerating tube is proposed for a betatron. An elastic body is wound and stuck spirally around the circular accelerating tube through the whole circle of the tube, so part of the tube surface is visible from outside. By this means, the construction of a betatron, etc., is rendered simple, and further the adhesion of the elastic body becomes much more secure. (NSA of Japan)

11904 BETATRON. Suematsu, Shigeru (to Hitachi Ltd.). Japanese Patent 1966-4960. Mar. 18, 1966. Filed July 14, 1964.

In the betatron proposed, the cooling mechanism for the central magnetic iron cores is improved. The magnetic iron cores consist of upper and lower cores, an insulating layer inserted in between; and insulating layers above and below the iron cores. Grooves running radially are cut on the surfaces of the insulating layers, which are in contact with the iron cores. Grooves corresponding to the radial grooves are also cut vertically on the outside of the rod inserted through the hole formed in the middle of the circular iron cores (and insulating layers). Cooling air is passed through these grooves for cooling of the iron (and insulating) cores. (NSA of Japan)

11905 PARTICLE ACCELERATING TUBE. Suematsu, Shigeru (to Hitachi Ltd.). Japanese Patent 1966-4959. Mar 18, 1966. Filed July 8, 1964.

In the particle accelerator proposed, the difference in thermal expansion between the electron-irradiation window and the welded glass part (which is the protrusion at a part of the circular accelerating tube) is reduced to protect the accelerating tube from destruction. When a metal cylindrical body with an electron window at one end is connected to the glass protrusion at a part of the circular accelerating tube, a glass cylindrical body is used between the protrusion and the metal body, embodied with the glass protrusion. (NSA of Japan)

11906 BETATRON X-RAY TUBE. Seki, Yoshitaka (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-4160. Mar. 12, 1966. Filed Oct. 11, 1963.

In the betatron x-ray tube proposed, an improvement is achieved in the x-ray producing target. The target has the plane surface on the side impinged upon by the accelerated electrons, but the other side from which the produced x-rays are emitted has a semicircular protrusion with the x-ray producing position (in the material) as the center. That is, when the x-rays produced at the center are radiated outward, the penetrating distances in the material are

nearly equal, irrespective of the direction of radiation, thus leading to the sufficiently uniform distribution of the x-ray intensities. By using this target proposed, therefore, an x-ray beam of high intensity having a large cross-sectional area can be obtained. (NSA of Japan)

11907 PARTICLE ACCELERATOR. Miyoshi, Katsuhiko (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-4958. Mar. 18, 1966. Filed July 18, 1964.

In the particle accelerator proposed, the palladium leak heater associated with the ion bottle (discharge tube) is heated by induction due to a high-frequency source. The particle accelerator consists of the following: an electrolytic cell containing an electrolyte for producing hydrogen gas; a palladium tube, installed on the side of the electrolytic cathode, which collects the evolved hydrogen gas; a high-frequency-induced heating wire, wound around the palladium tube, for adjusting the flow of collected hydrogen into the discharge tube; a high-frequency source for ionizing the hydrogen gas introduced into the discharge tube; an accelerating tube; and a target. (NSA of Japan)

11908 BETATRON. Tawara, Hiroyuki (to Hitachi Ltd.). Japanese Patent 1966-3200. Feb. 23, 1966. Filed Dec. 24, 1964.

In the betatron proposed, electric discharges from the electron-gun lead wire to the yokes and to the exciting coils can be prevented. The protrusion of the circular accelerating tube, in which the electron gun is contained, and the lead wire to the gun are surrounded by an insulating pipe. (NSA of Japan)

11909 SHIELD FOR A PARTICLE ACCELERATOR. Miyoshi, Katsuhiko (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-3198. Feb. 23, 1966. Filed Dec. 30, 1964.

An accelerator shield which is also used as a cooling-water tank is proposed. Using this method, large shields which surround accelerators are no longer needed, nor the direct use of city water for cooling an oil-diffusion pump and a target. The shield proposed is a water tank surrounding the part of an accelerating tube where neutrons are produced, and is provided with systems for circulating cooling water through the coolant channels of an accelerating tube. (NSA of Japan)

11910 PARTICLE ACCELERATING TUBE. Miyoshi, Katsuhiko (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-2960. Feb. 21, 1966. Filed June 10, 1964.

In the particle accelerating tube, the position of a target can be changed freely. By simple construction the sufficient adjustment of a focusing point in the required area can be achieved, furthermore, without using costly materials an accelerating tube of high stability can be given. The particle accelerating tube is provided with a target support, which is attached to the end of the accelerating tube and which is rotatable on the plane at right angles to the central axis of the tube, and has a target set onto the support eccentric from the tube axis. (NSA of Japan)

11911 ACCELERATING TUBE FOR A BETATRON. Seki, Yoshitaka (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-5119. Mar. 22, 1966. Filed Dec. 8, 1964.

In the accelerating tube proposed, an improvement was achieved in the support (or bolder) of a target. By the method proposed, the loss in the x-ray yield due to the malpositioning of a target in the accelerating tube can be eliminated. In the conventional methods, about 40% of the targets deviate by over 0.5 mm from the desired position, but by this method all targets can be positioned with the accuracy of 0.5 mm. A metal cylindrical body is fixed, air-tight, on its one end at an opening of the outside of the circular accelerating tube; the whole of the cylindrical body is outside the circular tube. An arm-shaped (inside the accelerating tube) rod, on top of which is held a target, is inserted through the metal cylindrical body; this rod is held air-tight at the outside end of the cylindrical body. This rod with a target is movable through the cylindrical body, and after adjustment of the target position it is held air-tight at the said cylindrical-body end. (The metal cylindrical body may be fixed inside the accelerating tube.) (NSA of Japan)

11912 SLIT DEVICE PLACED IN A HIGH VACUUM FOR A CHARGED PARTICLE BEAM. Fujiwara, Seiichi (to Mitsubishi Heavy Industries, Ltd.). Japanese Patent 1966-1440. Feb. 3, 1966. Filed May 9, 1964.

An improved slit device is proposed for measuring the energy of a charged-particle beam from an accelerator by measuring the current passing through the analyzer while deflected by a deflection magnet. The charged-particle beam slit device in a high vacuum consists of the following: the slit spindles (axes) to prevent the passage of a charged-particle beam; bellows installed air-tight with respect to the outer surface of the axial spindles and their fixing supports; and the guide tubes engaging with the outer ends of the spindles through the cut threads (the spindles run through the inner space of the bellows). By rotating the guide tubes, the spindles move forward and backward for intersecting the charged-particle beam. (NSA of Japan)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 10316, 11707, 12011, and 12267.

11913 (AAEC-E-150) GYMEA EDITOR USER'S GUIDE. Ford, G. H. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Apr. 1966. 160p. Dep. mn.

The GYMEA editor prepares standard binary GYMEA cross section library tapes from free format input data cards interspersed with control cards. The library tapes thus created may be input to other editor runs to list, punch, or copy selected nuclides, or, update runs may be used to create new libraries, alterations being possible in a variety of ways. The output from any successful update run is always another binary library tape in standard form. (auth)

11914 (AE-259) ANALYSIS OF THE QUASI-ELASTIC SCATTERING OF NEUTRONS IN HYDROGENOUS LIQUIDS. Purohit, S. N. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Nov. 1966. 26p. Dep. mn.

A critical discussion of the quasi-elastic scattering of neutrons by incoherent (hydrogenous) liquids is presented. Using the line-shape expression, a comparative discussion of several phenomenological models was carried out. An extension of the Singwi-Sjölander zero phonon expression, for the jump-diffusion model, to include the one phonon expression was also given. For a delayed diffusion model a complete treatment of $S(K,\omega)$ is presented. Along the lines of the macroscopic diffusion cooling, a microscopic diffusion cooling effect in fluids is speculated. (auth)

11915 (AEEW-M-683) MODIFICATIONS TO GROD. A Program for the Graphical Representation of Data in the Aldermaston and Winfrith Nuclear Data Library. Norton, D. S. (Atomic Energy Establishment, Winfrith (England)). Sept. 1966. 27p. Dep. BIS $0.80. HMSO 4s.

The program GRØD, which has been described elsewhere, is written in S.2 Fortran for use on the IBM 7030 computer and SC4020 at Aldermaston and is used to produce graphical representations of data in the Aldermaston and Winfrith Nuclear Data Library. Further use of the program at Winfrith has resulted in the detection of several faults and has shown the need for some extensions. Details of the modifications are given, and a listing of the modified program is included. (auth)

11916 (ANL-6172) TABLES OF DIFFERENTIAL CROSS SECTIONS FOR SCATTERING OF NEUTRONS FROM VARIOUS NUCLEI. Lane, R. O.; Langsdorf, A. S. Jr.; Monahan, J. E.; Elwyn, A. J. (Argonne National Lab., Ill.). [nd]. Contract W-31-109-eng-38. 226p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Experimental values of the neutron differential scattering cross sections of ^{9}Be, Ca, ^{12}C, Pb, Li, ^{6}Li, ^{7}Li, ^{16}O, Si, S, and Sn are tabulated, together with values obtained by a least-squares fitting of the data, and the error matrix resulting from the least-squares calculation. (D.C.W.)

11917 (BMwF-FBK-66-18) EXAKTE LOESUNG DER MONOENERGETISCHEN NEUTRONEN-TRANSPORTGLEICHUNG MIT LINEAR-ANISOTROPER STREUFUNKTION IN EBENER GEOMETRIE, DEMONSTRIERT AM BEISPIEL DES MILNE-PROBLEMS. (Exact Solution of Monoenergetic Neutron Transport Equation with Linear Anisotropic Scattering Function in Plane Geometry, Demonstrated for the Milne Problem as Example). Haungs, G. (Technische Hochschule, Karlsruhe (West Germany). Institut fuer Struktur der Materie). July 1966. 102p. (In German). Dep. mn.

The starting point of this work is the spherical harmonics method with linear anisotropic scattering as elaborated by W. Kofink. For the classical example of the transport theory, the Milne Problem, the solution is given in an P_L approximation. With a generalized H-function of Chandrasekhar the limit $L \to \infty$ is performed, and the exact solution is obtained. The influence of the anisotropy on the important entities is numerically calculated and graphed. The method outlined for the transition to the exact solution is not restricted to the Milne Problem, therefore it can be transferred to multilayer problems in plane geometry. (auth)

11918 (BMwF-FBK-66-21) NEUTRONENSPEKTREN IN HOMOGENEN, UNENDLICH AUSGEDEHNTEN, BELIEBIGEN MODERATOREN. (Neutron Spectra in Infinite, Homogeneous Arbitrary Moderators). Rietschel, H. (Technische Hochschule, Karlsruhe (West Germany). Institut fuer Struktur der Materie). July 1966. 46p. (In German). Dep. mn.

A mathematical method for calculating neutron spectra in homogeneous infinite media with absorption proportional to $E^{-0.5}$ is outlined. It is shown that the properties of the moderator concerning thermalization can be characterized by 5 parameters with excellent accuracy. This procedure represents an enlargement of a method given by Kunze, where the heavy gas operator is replaced by a Horowitz operator. (auth)

11919 (BNL-325(2nd Ed.)(Suppl.2)(Vol.2B)) NEUTRON CROSS SECTIONS. VOLUME IIB. Z = 41 TO 60. Goldberg, Murrey D.; Mughabghab, Said F.; Purohit, Surendra N.; Magurno, Benjamin A.; May, Victoria M. (Brookhaven National Lab., Upton, N. Y.). May 1966. Contract AT(30-2)-Gen-16. 418p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A compilation of neutron cross sections and resonance parameters is presented for nuclei with Z = 41 to 60 for neutron energies between 0 and 200 MeV. The energy dependence of the cross sections is stressed. (D.C.W.)

11920 (BNL-9607) THERMAL SPECTRUM MEASUREMENTS IN SLIGHTLY ENRICHED URANIUM, LIGHT WATER MODERATED LATTICES, BY THE LUTETIUM ACTIVATION METHOD. Tassan, S. (Brookhaven National Lab., Upton, N. Y.). Sept. 1965. Contract AT(30-2)-Gen-16. 22p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thermal spectrum measurements in light-water moderated 1% enriched uranium 0.387 in.-dia. rod lattices were performed by the lutetium activation method, in order to test the usefulness of this technique in not-well-thermalized lattices. ^{164}Dy and ^{175}Lu were used as reference thermal-neutron detectors. The experimental results are presented as the average values of the normalized (lattice/Maxwellian) activation ratios of ^{176}Lu/Dy and ^{176}Lu/^{175}Lu, with the pertinent cadmium-ratios, in the fuel and in the moderator over the W/U range from 1:1 to 4:1. The agreement with the results of a calculation performed using the THERMOS code is satisfactory. It is concluded that the ^{176}Lu/Dy set appears to be adequate for the thermal spectrum analysis of light-water-moderated lattices, while the ^{175}Lu/Dy set can provide rather accurate integral data for the epithermal component of the neutron spectrum. (auth)

11921 (EUR-3151.e) STUDIES OF ^{240}Pu RESONANCE ABSORPTION IN HETEROGENEOUS SYSTEMS. Beonio-Brocchieri, F.; Diana, E. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Aug. 16, 1966. 20p. Dep. mn.

Neutron resonance absorption by ^{240}Pu in heterogeneous systems was studied by a method in which detailed spatial distributions in the different regions and energy depression in the moderator were taken into account. The results were compared with experimental data. (S.F.L.)

11922 (EUR-3154.e) COMPUTER PROGRAM FOR THE CONSTRUCTION OF TABLES OF GAMMA PEAKS AND FOR CALCULATION OF SPECIFIC ACTIVITIES OF RADIOISOTOPES FORMED BY (n,γ) REACTION. Guzzi, G.; Pauly, J.; Girardi, F.; Dorpema, B. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Aug. 16, 1966. 64p. Dep. mn.

A computer program called LIBRAR was developed in order to derive tables of gamma peaks classified according to their energy and to calculate the specific activities of peaks from radioisotopes produced by (n,γ) reactions. Photoelectric peaks and double escape peaks were considered. The input data include the efficiency curves of the detector, cross-sections, and gamma-ray abundances of the isotopes considered; for these last quantities either literature data or values determined experimentally were used. The program and an example of the output data are given. (auth)

11923 (GA-6906) TACASI: A FORTRAN IV CODE FOR LEAST SQUARES AREA ANALYSIS OF NEUTRON RESONANCE DATA. Froehner, F. H. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Aug. 4, 1966. Contract AT(04-3)-167. 125p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A computer program, TACASI, for the determination of neutron resonance parameters by least-squares area analysis of neutron resonance data is described. The least-squares formalism is outlined, and a listing of the program is included. (D.C.W.)

11924 (GA-7417) GASKET: A UNIFIED CODE FOR THERMAL NEUTRON SCATTERING. Koppel, J. U.; Triplett, J. R.; Naliboff, Y. D. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Sept. 22, 1966. Contract AT(04-3)-167. 80p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The computer code GASKET, which was developed as a unified method for calculating thermal neutron scattering kernels for all moderators, is described. (S.F.L.)

11925 (IFA-FN-28) SMALL-ANGLE CRITICAL MAGNETIC SCATTERING OF NEUTRONS IN IRON. Bally, D.; Grabcev, B.; Lungu, A. M.; Popovici, M.; Totia, M. (Academia R. P. R., Bucharest. Institutul de Fizica Atomica). 1966. 16p. Dep. mn.

Measurements of the temperature variation of the small-angle critical scattering of 1.25 Å neutrons by iron were performed. Taking into account the inelasticity of the scattering, the parameters which define the instantaneous spin correlation function of Ornstein–Zernicke form were determined. This form of the function turned out to be valid at distances larger than 15–20 Å. For smaller distances, it was confirmed that the instantaneous correlation function has the form of a simple exponential. From the data for $T - T_C > 10°C$ it was deduced that the temperature variation of the static magnetic susceptibility is of the form $(T - T_C)^{-(1.30\pm0.04)}$. In the nearest proximity of the critical temperature T_C there were noticed no significant deviation from this dependence. (auth)

11926 (INR-731/IXA/R) NEUTRON DIFFUSION PARAMETERS OF EPOXY RESIN. Graffstein, A.; Rzeszot, T.; Warda, E. (Institute of Nuclear Research, Warsaw (Poland)). June 1966. 10p. Dep.

The thermal-neutron diffusion parameters of epoxy resin were measured using the pulsed-neutron method. As a pulsed-neutron source, the fast chopper operating at the horizontal channel of the EWA reactor was used. The measurements were performed in the buckling range from 0.068 to 0.868 cm^{-2}. (auth)

11927 (LA-3617) BIORTHOGONAL ANGULAR POLYNOMIAL EXPANSIONS OF THE BOLTZMANN TRANSPORT EQUATION. Lathrop, K. D.; DeMuth, Nelson S. (Los Alamos Scientific Lab., N. Mex.). Oct. 1, 1966. Contract W-7405-eng-36. 64p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A system of biorthogonal polynomials is developed for the angular expansion of the directional flux in the linear Boltzmann transport equation. Recursion relations and an addition theorem are derived for a system of biorthogonal polynomials shown by Didon to be orthogonal over the unit hemisphere. These polynomials are applied to two-dimensional forms of the Boltzmann equation. Equations for the coefficients of expansion are derived when the directional flux is expanded in a series of either system of polynomials. One of these systems of equations is shown to be a linear combination (with specific coefficients) of the equations obtained when the directional flux is expanded in spherical harmonic functions, and it is shown that this same system reduces to the spherical harmonics equations in one-dimensional plane geometry. (auth)

11928 (NAA-SR-Memo-12085) NAA PROGRAM DESCRIPTION CLIO: CAESAR IV LIBRARY INPUT OUTPUT CODE. Baller, D. C. (Atomics International, Canoga Park, Calif.). Sept. 1966. Contract AT(11-1)-Gen-8. 22p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A description is given of the CLIO FORTRAN IV program which uses the CAESAR IV microscopic binary libraries prepared by LIBLIST to produce a material-dependent neutron cross section tape for use with CAESAR IV. (S.F.L.)

11929 (NP-16445) ETUDE DU RALENTISSEMENT DES NEUTRONS DANS LA MATIERE. (Studies of Slowing Down Neutrons in Substances). Kaper, Hans Gerard (Groningen Rijksuniversiteit (Netherlands)). 1965. 110p. (In French). Dep. mn.

Thesis.

The general equation of slowing down in given, and some methods proposed for its solution are reviewed. In the A^{-N} approximation the Fourier transformation of the total density of collisions obeys an ordinary differential equation of N order. The solution for the total collision density is then possible, at least in principle. It is shown that by making A approach infinity the differential equation is reduced to an algebraic equation whose solution leads to an expression for the collision density which is known from group theory. The solution of the slowing-down equation in the A^{-1} approximation is given. Numerical results are reported. For a medium with constant cross sections, the shape of the expression of the collision density was determined by the A^{-1} approximation when the mass number is large. The behavior of the collision density at large distances from the source was studied with respect to the total mean free path. A formal series development representing this asymptotic behavior was deduced. (J.S.R.)

11930 (ORNL-P-2643) PROMPT-NEUTRON TIME BEHAVIOR IN DELAYED-CRITICAL COUPLED URANIUM-METAL CYLINDERS. Mihalczo, J. T. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 20p. (CONF-661019-6). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Conference on Fast Critical Experiments and Their Analysis, Argonne, Ill.

Pairs of identical coaxial 27.94-cm-dia cylinders of unmoderated and unreflected U metal were assembled to delayed criticality with large spaces between the flat surfaces. The U metal was enriched to 93.15 wt % in the ^{235}U isotope. Prompt-neutron decay constants of the assemblies were measured by the Rossi-α technique, and the results agreed with those predicted by a method in which a pair of equations represented the kinetics of a coupled-core assembly. The equations neglected delayed neutrons and assumed space-independent kinetics for each cylinder with a time lag to represent the flight time of neutrons from one cylinder to the other. Multiplication factors calculated for the assemblies using S_8 transport theory also agreed with the experimental values. (auth)

11931 (RT-FIMA-(66)-3) COMPARISON BETWEEN THE ELMOE AND THE ITERATIVE METHODS TO GENERATE TRANSPORT AND ELASTIC REMOVAL CROSS SECTIONS FOR FAST REACTOR EVALUATIONS. Gandini, A.; Salvatores, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 12p. Dep. mn.

Elastic removal and transport cross sections were calculated for the case of a dilute PuO_2-fueled, Na-cooled fast reactor using the ELMOE code and an iterative method. Comparison of the results obtained by the two methods indicates that the iterative method is applicable to typical problems of interest. (D.C.W.)

11932 (TID-23357(Suppl.1)) CINDA: AN INDEX TO THE LITERATURE ON MICROSCOPIC NEUTRON DATA. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn. ENEA Neutron Data Compilation Centre, Gif-sur-Yvette (France)). Oct. 15, 1966. 327p. (EANDC-66(U); CCDN-CI-13). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A compilation of all the additions entered into the CINDA master library tape between July 1, 1966 and Oct. 15, 1966 is presented. Corrections and improvements to previous entries are included. (D.C.W.)

11933 (WAPD-TM-617) A METHOD OF INCLUDING EPITHERMAL NEUTRON SCATTERING BY BOUND PROTONS IN COMBINED SLOWING-DOWN/THERMAL CALCULATIONS BY MONTE CARLO. Candelore, N. R.; Gast, R. C. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Oct. 1966. Contract AT(11-1)-Gen-14. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A method of including epithermal neutron scattering by bound protons in combined slowing down-thermal calculations by the Monte Carlo method is suggested by the theoretical work of Corngold. A comparison of experiments and calculations using this method reveals that it is sufficient to account for epithermal binding effects in H_2O as reflected in the epithermal flux and in the detailed slowing-in-source to thermal energy. (auth)

11934 (ORNL-tr-1372) DEVELOPMENT OF STOCK-CAR COMPUTER PROGRAM FOR FLUX AND DOSE DUE TO A SOLID OR TORIC CYLINDRICAL SOURCE. Daversin, Bernadette (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated by Gregory L. Boisvert (Oak Ridge National Lab., Tenn.), from report CEA-N-575. 10p. Dep. mn. JCL $1.10 fs, $0.80 mf.

A computer program for the calculation of the flux, the energy flow, and the radiation dose due to a solid or toric cylindrical source at a point on a horizontal axis passing through the lower base of the cylinder is described. (D.C.W.)

11935 COLD NEUTRON SCATTERING BY MOLECULAR LIQUIDS. III. METHANE. Sears, V. F. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 45: 237-54 (Feb. 1967). (AECL-2832).

It is shown that a relation exists between cold neutron scattering by simple molecular liquids and the corresponding infrared and Raman spectra of these substances. In particular, for liquids in which statistical correlations between the rotational and translational motion are negligible, the contribution of the rotational motion to the cold neutron scattering cross sections can be obtained from the infrared and Raman rotation-vibrational line-shape functions, thereby enabling one to interpret the observed cross sections directly in terms of the translational motion of the molecules. Numerical calculations are carried out for liquid methane and are compared with recently observed cross sections. (auth)

11936 DOSIMETRY AND SHIELDING WITH A 14-MeV NEUTRON GENERATOR. Hacke, J. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Int. J. Appl. Radiat. Isotop., 18: 33-44 (Jan. 1967). (In German).

For a 14-MeV neutron generator, which is used mainly for fast neutron experiments, the distribution of flux density and dose equivalent, as well as the effectiveness of shielding, were investigated. Dose equivalent measurements were performed with an Andersson and Braun type dosimeter, which fits the whole

energy range 0.025 eV ≤ E ≤ 14 MeV. Dose equivalent transmission factors of normal concrete were determined in the range of 130 to 160 cm thickness, resulting in a relaxation length of 15 cm. The results of shielding measurements are compared with results obtained from different methods of shielding calculations. In order to compare different neutron dosimeters, some measurements were made in regions with different neutron spectra. (auth)

11937 FLUX DENSITY CLOSE TO THE TARGET OF A NEUTRON GENERATOR. Wilkniss, P. E.; Wynne, G. J. (Naval Propellant Plant, Indian Head, Md.). Int. J. Appl. Radiat. Isotop., 18: 77-81(Jan. 1967).

An expression is developed for calculating the neutron flux distribution in the neighborhood of a disk-shaped target, taking account of the orientation of the detector relative to the source. Calculated values are compared with data obtained empirically, using a commercial 14-MeV neutron generator. Some of the problems involved in ignoring detector orientation are pointed out, and a development of an expression for flux which takes into account detector orientation is outlined. Calculated values are compared with data obtained empirically. (auth)

11938 DOUBLY BENT TOTAL REFLECTING TUBE AS COLD NEUTRONS FILTER. Buzano, C.; Demichelis, F.; Rasetti, M. (Politecnico, Turin). Nucl. Instrum. Methods, 47: 320-6 (1967).

The performance of a doubly bent total reflecting tube as a cold neutron filter was examined. The calculated neutron distributions after passage through a doubly bent tube and a cooled filter are compared. In both the cases the characteristic feature of the resulting transmitted spectra is a sharp break at a particular wavelength λ_c and an intensity which decreases with increasing wavelength. In the case of the doubly bent reflecting tube the cutoff wavelength λ_c depends only on the shape and dimensions of the tube. (auth)

11939 ABSOLUTE MEASUREMENT OF EFFECTIVE NEUTRON EXCITATION CROSS SECTIONS IN THE keV REGION WITH A FAST PULSED ARRANGEMENT. Miessner, Horst; Arai, Eiichi (Kernforschungszentrum, Karlsruhe, Ger.). Nukleonik, 8: 428-35(Nov. 1966). (In German).

Effective (resonance self-shielded) capture and transport cross sections were obtained for lead at a neutron energy of 30 keV and for uranium at 30 keV and 7.5 keV by fast neutron lifetime measurements. The measured effective cross sections are compared with calculated self-shielding factors and "infinite dilution" cross sections, obtained by other authors. (auth)

11940 SPACE-TIME FLUX DISTRIBUTION IN NEUTRON TRANSPORT THEORY. Boffi, V. C. (CNEN, Bologna). Nukleonik, 8: 448-61(Nov. 1966).

The exact integration of the space-time dependent Boltzmann equation which governs the flux distribution of monoenergetic neutrons in the case of an infinite medium, spherically symmetric scattering, and an isotropic infinite planar pulsed source is worked out. Separation of the two contributions due to the pole and essential singularity, respectively, of the Fourier transform of the sought total flux and application of the method of steepest descents allow a qualitative and quantitative comparison to be made between the result of the simple diffusion theory and that here obtained in the framework of the rigorous transport theory. (auth)

11941 CENTRAL LIMIT IN TRANSPORT THEORY. Syros, Constantin (EURATOM-CCR, Ispra, Italy). Nukleonik, 8: 461-7(Nov. 1966).

By expanding the neutron propagator of the infinite homogeneous medium in a series of ascending powers of the coupling constant of the neutron field with the medium, a new representation of the neutron distribution is obtained. The energy- and space-dependent distribution can be constructed if the energy-independent and space-independent distributions are given in the same representation. (auth)

11942 GENERALIZATION OF THE MULTIPLE COLLISION METHOD. Syros, Constantin (EURATOM-CCR, Ispra, Italy). Nukleonik, 8: 467-71(Nov. 1966).

A generalization of the multiple collision method for the solution of nonlinear equations is presented. The method was applied to the solution of the transport equation with anisotropic scattering kernel. (auth)

11943 MILNE PROBLEM FOR THERMAL NEUTRONS WITH ABSORPTION. Arkuszewski, Jacek (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 27: 104-19(Jan. 1967). (BNL-10045).

The Wiener–Hopf factorization method was applied to the energy-dependent Milne problem with simple separable isotropic kernel and absorption of $1/v^n$ type. Extensive numerical calculations for free gas scattering cross sections were performed; partial results are presented. Discussion of these results, namely the critical absorption coefficients, discrete space eigenvalues, extrapolation distances, and emergent neutron distributions confirm the earlier assertion of Williams that critical absorption as well as asymptotic spatial parameters depend rather weakly upon the energy exchange mechanism, being more sensitive to the energy dependence of the mean free path. Nelkin's model for water was also studied, in the form of a separable kernel. The critical absorption as well as discrete spatial eigenvalues for this case appear to be in good agreement with values obtained by Honeck for the full isotropic Nelkin kernel. (auth)

11944 AN IMPROVED TREATMENT OF SCATTERING RESONANCES IN SLAB GEOMETRY. Cohen, Sanford C. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nucl. Sci. Eng., 27: 133-5(Jan. 1967). (GA-7144).

The inadequacy of the conventional flat-source treatment of highly scattering resonances was demonstrated for ^{186}W. Calculations of the resonance integrals of ^{186}W by the flat-source approximation were compared with exact calculations. The results indicate that the flat-source restriction can be retained in the moderator, but that it should be relaxed in the lump. (D.C.W.)

11945 INFLUENCE OF MOLECULAR BINDING EFFECTS IN WATER ON MEASURED RESONANCE INTEGRALS. Hardy, J. Jr. (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Sci. Eng., 27: 135-6(Jan. 1967). (WAPD-T-1917).

The effect of binding on flux spectra in H_2O above 0.5 eV was studied. The effective resonance integrals of ^{238}U rods were measured relative to the dilute ^{238}U resonance integral. (D.C.W.)

11946 AN ANALYTIC TREATMENT OF THE "FLUX BUMP" IN RESONANCE ABSORPTION. Pomraning, G. C.; Dyos, M. W. (General Atomic, San Diego, Calif.). Nucl. Sci. Eng., 27: 137-9 (Jan. 1967).

An analytic approximation for the calculation of resonance integrals, which gives good results for both strongly absorbing resonances (no bump) and strongly scattering resonances (for which a bump can exist), is outlined. (D.C.W.)

11947 A GENERALIZED RESONANCE INTEGRAL CORRELATION FOR URANIUM RODS. Strawbridge, L. E. (Westinghouse Electric Corp., Pittsburgh). Nucl. Sci. Eng., 27: 142(Jan. 1967).

The generality of a previously published resonance integral correlation was tested by correlating some experimental data on UC rods. (D.C.W.)

11948 A PLAUSIBILITY ARGUMENT BY B. DAVISON FOR THE COMPLETENESS OF THE ELEMENTARY SOLUTIONS TO THE ONE-DIMENSIONAL NEUTRON-TRANSPORT EQUATION. Hendry, W. L. (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng., 27: 143-4(Jan. 1967). (LA-DC-8326).

It is proved that the elementary solutions of the steady-state monoenergetic one-dimensional neutron transport equation form a complete set. (D.C.W.)

11949 EXPERIMENTAL INVESTIGATION OF FAST NEUTRON DECAYS IN LEAD ASSEMBLIES. Beghain, L. E.; Hofmann, F.; Wilensky, S. (Massachusetts Inst. of Tech., Cambridge). Nucl. Sci. Eng., 27: 80-4(Jan. 1967).

A pulse of monoenergetic fast neutrons of several nanoseconds duration is used to excite a lead assembly. The neutron decay is measured as a function of assembly size with conventional nanosecond time-of-flight equipment. The neutron detector is biased to eliminate all nonelastically scattered neutrons. A theoretical relation was developed by Paik which relates the assembly size to the measured decay constant. The nonelastic cross section appears as a parameter in Paik's theory and can be chosen to give the best fit to the experimental data. Decay constants were measured at 2.1 and 1.7 MeV for lead assemblies 20-in. wide × 20-in. high and thicknesses from 1 to 8 in. Paik's theory assumes the establishment of an asymptotic spatial decay mode. This assumption was verified by measuring the neutron decay at various positions of the assembly. The results show that it takes the order of 10 to 15 nsec to establish a spatial mode. This method was used to measure the total nonelastic cross section for lead at 2.1 and 1.7 MeV. (auth)

11950 MONTE CARLO CALCULATIONS OF RESONANCE INTEGRAL OF ^{232}Th. Sehgal, Bal Raj (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 27: 95-103(Jan. 1967). (BNL-10210).

Resonance integral calculations are done for ^{232}Th infinite dilute, ^{232}Th metal rod, and $^{232}ThO_2$ rod systems. Doppler effect calculations are performed for $^{232}ThO_2$ rod systems for temperatures up to 2000°K. The resolved resonance integral for rod systems at each temperature is evaluated by Monte Carlo calculations

and the resonance overlap effect between the two resonances of Th at 21.78 and 23.45 eV is taken into account. The unresolved s- and p-wave contributions were computed by standard methods. The data describing the resolved resonance parameters up to 3 keV (Γ_γ = 25.9 MeV) recommended in BNL-325 (Supplement No. 2, 1965) are used in these calculations. The p-wave strength function in the unresolved energy range is taken to be 1.83×10^{-4} $(eV)^{-\frac{1}{2}}$. The calculated resonance integrals and Doppler coefficients are compared with measurements; they are found to be in excellent agreement with each other. (auth)

11951 SLOWING DOWN OF NEUTRONS IN ZIRCONIUM HYDRIDE. Jauho, Pekka; Manninen, Jussi (Technical Univ. of Helsinki). Nucl. Sci. Eng., 27: 45-50(Jan. 1967).

A method based on a power series expansion of the neutron spectrum in time is used to solve the space-independent Boltzmann equation. The coefficients are obtained from a relatively simple recursion formula well suited for numerical calculations. Assuming the atoms of a hydrogenous moderator free when the neutron energy is large, this formula is further simplified. Adopting the Einstein oscillator model and transforming the recursion formula into a matrix equation, the time-dependent energy spectrum of neutrons in zirconium hydride was calculated. (auth)

11952 SLOWING DOWN SPECTRA OF NEUTRONS IN LITHIUM HYDRIDE. Verbinski, V. V. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 27: 51-66(Jan. 1967). (ORNL-TM-1077(Rev.)).

Measurements of the spectra of neutrons moderated in LiH were made in the energy range of about 0.01 to 600 eV, and the results were compared with calculated spectra obtained from a Monte Carlo calculation, a direct numerical integration of the Boltzmann equation (NIOBE code), a moments numerical calculation, and three infinite-medium thermalization calculations, each utilizing a different scattering kernel. The measurements were carried out by irradiating slabs of LiH with neutrons having a near-fission spectrum. The spectra of the leakage flux, of the forward-directed flux, and of the scalar flux within the slab were obtained at neutron penetrations of 2.5 to 10 cm. Below 30 eV, the leakage flux and scalar flux attained an asymptotic spectral shape at a penetration of 2.5 cm, and the forward-directed flux at about 5 cm. The shapes of the calculated spectra agree with the shapes of the measured spectra for all energy regions in which each calculation is valid. A large discrepancy between the NIOBE code predictions and the measurements below 0.08 eV is caused by upscattering and molecular binding effects, which are neglected by NIOBE. These effects were included in a neutron thermalization calculation for an infinite medium with a constant source density; however, good agreement with measurement was obtained only for the case in which the measurement had been made in a nearly gradient-free region. In a region of strong flux gradients, the spectrum of the forward-directed flux is shown to be related to that of the scalar flux with good accuracy by the Purohit expression, according to a NIOBE code calculation which yielded both spectra. (auth)

11953 DISPERSION LAW OF A MODERATOR. Moore, M. N. (San Fernando Valley State Coll., Northridge, Calif.). Nucl. Sci. Eng., 26: 354-61(Nov. 1966).

The homogeneous Boltzmann equation for a moderator is specialized for isotropic scattering kernels and is probed for wave solutions. There emerges a discrete set of wave numbers corresponding to the frequency ω as well as a continuum. The former constitutes a dispersion law having the same form as that based upon P_N multigroup theory; but, in general, the parameters are now given explicitly by inverse moments of $\nu\Sigma_T$ averaged over distributions determined by the scattering kernel. The accuracy of these constants does not depend upon assumptions regarding the neutron energy spectrum. The waves near the limit of detectability have wavelengths and attenuation lengths of the order of the maximum mean free path. Such attenuation lengths approach the continuum boundary. The waves near the continuum boundary have phase velocities approaching that particle velocity which minimizes $\Sigma_T(\nu)$. At frequencies above the minimum collision frequency, no discrete waves definitely propagate, but when the frequency is low enough for a set of discrete waves to be generated, their attenuation is always smaller than that of the accompanying continuum so that an asymptotic region exists in which conventional neutron wave measurements can still be carried out. The criterion for the existence of discrete waves at low frequencies is the same as that for the existence of discrete relaxation lengths in an exponential experiment. (auth)

11954 REACTION RATE OF NEUTRONS IN A MAXWELLIAN MEDIUM. Murray, Raymond L. (North Carolina State Univ., Raleigh). Nucl. Sci. Eng., 26: 362-5(Nov. 1966).

A general relation is derived for the reaction rate of neutrons of given speed with a Maxwellian distribution of nuclei. The expression is applicable to a cross section that varies with relative speed in an arbitrary manner and is shown to specialize to known results for $1/v$ absorption, a constant scattering cross section, and resonance capture with Doppler broadening. Although the approach yields well-known results, it suggests the possibility of analytical unification of reactor theory for both research and pedagogical purposes. (auth)

11955 COMPARISON OF STATISTICAL ESTIMATORS FOR NEUTRON MONTE CARLO CALCULATIONS. MacMillan, D. B. (Knolls Atomic Power Lab., Schenectady, N. Y.). Nucl. Sci. Eng., 26: 366-72(Nov. 1966). (KAPL-P-3127).

Several statistical estimators that may be used in neutron Monte Carlo calculations are compared by means of idealized problems. The objective is to evaluate these estimators for use in the study of neutron thermalization and thermal neutron behavior by Monte Carlo techniques. It is concluded that the minimum variance linear combination of the analog estimator and the modified path length estimator (proposed recently by Spanier) is the best of these estimators for such applications. Where computer limitations require the use of a simple (rather than a combination) estimator, the modified path length estimator is recommended. (auth)

11956 INVESTIGATION OF RESONANCE ABSORPTION IN MIXTURES OF ^{238}U AND ^{232}Th. Foell, W. K. (Phillips Petroleum Co., Idaho Falls, Idaho); Connolly, T. J. Nucl. Sci. Eng., 26: 399-417(Nov. 1966).

Measurements of resonance absorption of neutrons were performed on single-absorber systems containing ^{238}U and ^{232}Th individually, and in binary systems containing mixtures of these two absorbers. The single-absorber measurements were made over a wide range of absorber concentrations and served as a check on the adequacy of resonance absorber calculations and/or resonance parameter data. The binary systems provided a situation in which the spacing of resonances is closer than in a single absorber, thus making questionable the usual assumption of separability of resonances. The measurements were performed by means of static reactivity techniques in the Advanced Reactivity Measurement Facility (ARMF-II) at the National Reactor Testing Station in Idaho. The calculated and measured values for the uranium dioxide systems are in good agreement over the wide range of absorber concentrations. The experimental results for the thorium dioxide samples are consistent with work by other experimenters but are in quantitative disagreement with resonance integrals calculated from a recent compilation of resonance parameters. The measured resonance integrals of the binary mixtures were smaller than the values predicted from the measurements on the single-absorber systems, indicating an interference effect of approximately 3% in the samples of highest absorber concentration. Calculations performed with a multiresonance version of Nordheim's ZUT code underestimated this interference effect between absorbers. (auth)

11957 ALBEDO PROBLEM AND CHANDRASEKHAR'S H-FUNCTION. Abu-Shumays, I. (Harvard Univ., Cambridge, Mass. Argonne National Lab., Ill.). Nucl. Sci. Eng., 26: 430-1(Nov. 1966).

Analytic approximations for the albedo problem (reflection functions) for a semi-infinite medium with isotropic scattering are proposed. The directional and net reflection functions (albedos) are related to Chandrasekhar's H-function. (D.C.W.)

11958 CAVITY AND VACUUM BOUNDARY CONDITIONS FOR MORE-DIMENSIONAL P_N APPROXIMATIONS. Emendoerfer, D. (Technische Hoschschule, Stuttgart). Nucl. Sci. Eng., 26: 431-2 (Nov. 1966).

Cavity and vacuum boundary conditions for P_N approximations are derived using neutron-balance considerations. (D.C.W.)

11959 FINE GROUP CROSS SECTIONS OF RESONANCE ABSORBERS. Pollard, J. P. (Australian Atomic Energy Commission, Lucas Heights, New South Wales). Nucl. Sci. Eng., 26: 432-3(Nov. 1966).

An equation for multigroup resonance cross sections with fine groups is derived. (D.C.W.)

11960 NEUTRON GENERATOR. Inoue, Takashi (to Matsushita Electric Industrial Co., Ltd.). Japanese Patent 1965-24599, Oct. 27, 1965. Filed July 22, 1963.

A neutron generator is proposed in which an improvement is made to the target for the $T(d,n)^4He$ reaction. The efficiency is increased with regard to the accelerating voltage and the neutron yield. In the vacuum space provided by an outer vessel are installed the ion source and the ion accelerating electrodes. At the entrance of ions from the source there exists a pressure difference, in the space where the electrodes are located, from the vacuum space. The space is filled with the deuterium or tritium target gas. (auth)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 11975, 11989, 12011, and 12063.

11961 (JINR–E3-3030) CHOICE OF THE PROPER SET OF NEUTRON–DEUTERON SCATTERING LENGTHS FROM EXPERIMENTS ON TRANSMISSION OF POLARIZED NEUTRONS THROUGH A POLARIZED DEUTERON TARGET. Alfimenkov, V. P.; Lushchikov, V. I.; Nikolenko, V. G.; Taran, Yu. V.; Shapiro, F. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1966. 10p. Dep. mn.

An experiment is described by which a choice was made between two previously reported sets of n-d scattering lengths. The dependence of the transmission of neutron through a deuterium target on the polarization was used. (D.C.W.)

11962 THE LIFETIME OF $^3H_\Lambda$. Rayet, M. (Univ. Libre, Brussels); Dalitz, R. H. (Nuovo Cimento (10), 46A: 786-94 (Dec. 21, 1966).

The various contributions to the decay lifetime of $^3H_\Lambda$ which could conceivably contribute to the large value observed are discussed. The effect of the phase-space factor and of the Pauli principle, nonmesic decay, and final-state pion scattering are estimated. (L.B.S.)

11963 DECAY OF HYPERNUCLEI INTO TWO Λ PARTICLES. Vedrinskii, R. V.; Kolesnikov, N. N. Vestn. Moskov. Univ., Ser. III: Fiz. Astron., No. 4, 116-8(July-Aug. 1966). (In Russian).

The correlations in the cascade decay of hypernuclei with two particles were investigated. The study is limited to processes in which the nucleons of the participating nuclei are found in the f state. It was concluded that the correlations of the planes of the first and second decays are absent because the spin correlates with the pulse of mesons (π) and does not depend on the decay plane. The correlations sharply decrease with increase of the spin of the shell of the intermediate hypernuclei which is easily understood because in this case the role of the spin of the Λ particles (on which the correlation depends) decreases. Insignificant correlations between the angular distributions between the first and second decay are possible. Correlation between the direction of emission of the meson(π) at the first and second decay can be very significant. (tr-auth)

11964 A SEARCH FOR UNBOUND T = ½ LEVELS IN ^{3}He. Warner, R. E. (Oberlin Coll., Ohio); Vincent, J. S.; Boschitz, E. T. Phys. Lett., 24B: 91-2(Jan. 23, 1967).

Energy spectra of inelastically scattered α particles from the $\alpha + {}^3$He reaction were measured, yielding no groups corresponding to the unbound ^{3}He levels reported by Kim, et al. (auth)

11965 EFFECTIVE RANGE ANALYSIS OF s- AND d-WAVE α-α SCATTERING. Rasche, G. (Univ., Zurich). Nucl. Phys., A94: 301-12(1967)

The new Q-value E_r and width Γ of the ^{8}Be ground state as determined by the Zurich group were analyzed with the low-energy α-α s-wave phase shifts δ_0 to determine the effective range expansion parameters of the phase shift δ_0. Use of these parameters gives better limits on Γ than the direct experimental limits quoted previously. The maximum of δ_0 as a function of the center-of-momentum energy is calculated to be very close to 180°, but does not exceed this value. The order of magnitude of δ_2 in this energy region is estimated on the basis of an effective-range analysis for l = 2; it is seen that δ_2 is negligible. (auth)

11966 MEASUREMENTS OF THE ABSOLUTE YIELD OF 14-MeV NEUTRONS BY MEANS OF RECORDING OF THE α PARTICLES IN T(d,n)^{4}He REACTION. Mirsalikhova, F. Kh.; Skorodumov, B. G.; Talanin, Yu. N. (Inst. of Nuclear Physics, Academy of Sciences, Uzbek SSR). Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk, No. 4, 57-60(1966). (In Russian).

The relations between the total and differential neutron currents, on the one hand, and the number of α particles registered by the detector, which was arranged at angles of 90, 135, and 180° to the deuteron direction, on the other hand, were determined. (J.S.R.)

11967 THE D(d,n)^{3}He AND D(d,p)^{3}H REACTIONS WITH POLARIZED DEUTERONS AT 460-kev INCIDENT ENERGY. Huber, P.; Petitjean, C.; Paetz gen. Schieck, H.; Striebel, H. R. (Univ., Basel). 9p. (In German). (CONF-660404-1). ORAU.

From Spring Meeting of the Swiss Physical Society, Bern.

The four components of the polarization sensitivity $P^a(\theta)$, $P^a_{33}(\theta)$, $P^a_{13}(\theta)$, and $P^a_{11}(\theta) - P^a_{22}(\theta)$ of the D(d,n)^{3}He and the D(d,p)^{3}H reactions were determined at the incident energy of 460 keV. The angular dependence was measured and the results were compared with the theoretical assumptions of Rook and Goldfarb. (J.S.R.)

Nuclear Properties and Reactions, 6≤A≤19

Refer also to abstracts 11989, 12011, 12024, 12027, 12062, 12063, 12083, and 12114.

11968 (GEMP–470) BERYLLIUM NINETEEN GROUP CROSS SECTIONS. Kamphouse, J. L. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Mar. 20, 1964. Contract AT(40-1)-2847. 33p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The nineteen-group beryllium cross sections have been revised using the most recent data. The entire problem of the treatment of beryllium is being investigated, and the status of that work is given. Special emphasis is given to the treatment of the (n,2n) reaction. (auth)

11969 (JINR–P3-3079) UGLOVYE RASPREDELENIYA NEITRONOV IZ REAKTSII ^{12}C(t,n)^{14}N. (Angular Distributions of Neutrons From the ^{12}C(t,n)^{14}N Reaction). Malushinska, K.; Pshitula, M.; Sizov, I. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1966. 11p. (In Russian). Dep. mn.

The energy spectra and angular distributions of three groups of neutrons from the ^{12}C(t,n)^{14}N reaction, which correspond to the main and two first excited states of a final ^{14}N nucleus were measured. The measurements were performed by the nuclear photoemulsion method at $E_t \approx 1.7$ MeV. The angular distributions of the n_1 group neutrons (2.31-MeV state of ^{14}N) are compared to that of protons from the ^{12}C(t,p_0)^{14}C reaction for the ground state of ^{14}C. The proton-neutron angular distributions for the corresponding states of final nuclei are similar. (auth)

11970 (NP–16415) ANALISIS TEORICO DE LA ESTRUCTURA NUCLEAR DEL ^{19}O. (Theoretical Analysis of the Structure of ^{19}O Nuclei). Fosado Penaloza, Mario Efren (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ciencias). 1965. 69p. (In Spanish). Dep. mn.

Thesis.

On the basis of the nuclear shell model, the energy levels of the ^{19}O nucleus were calculated using as the residual interaction between the three nucleons outside the closed shell the interaction model which consists of a linear combination of a quadrupole-quadrupole interaction, pairing interaction, and spin-orbit interaction. The interaction thus expressed in second quantization language is calculated by means of basic techniques in group theory. Strictly only the second quantization technique is used in order to take into account the antisymmetry of the wave functions describing fermions so that the nucleon number is considered to be constant. The energy-level spectra calculated theoretically were compared with the experimental values, and the values of the parameters for the best fit were found. (tr-auth)

11971 ABSOLUTE ISOTOPIC ABUNDANCE RATIOS AND ATOMIC WEIGHT OF MAGNESIUM. Catanzaro, Edward J.; Murphy, Thomas J.; Garner, Ernest L.; Shields, William R. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand., 70A: 453-8(Nov.-Dec. 1966).

Absolute values were obtained for the isotopic abundance ratios of magnesium, using surface emission mass spectrometry. Samples of known isotopic composition, prepared from nearly pure separated magnesium isotopes, were used to calibrate the mass spectrometers. The resulting absolute values are $^{25}Mg/^{24}Mg = 0.12663 \pm 0.00013$ and $^{26}Mg/^{24}Mg = 0.13932 \pm 0.00026$, yielding an atomic weight ($^{12}C = 12$) of 24.30497 ± 0.00044. The indicated uncertainties are overall limits of error based on 95% confidence limits for the mean and allowances for effects of known sources of possible systematic error. (auth)

11972 EXCITED STATES OF ^{16}O IN THE HARTREE–FOCK (HF) APPROXIMATION. Muthukrishnan, R. (Univ. of Michigan, Ann Arbor). Can. J. Phys., 45: 333-7(Feb. 1967).

The intrinsic 4-particle, 4-hole state of ^{16}O is calculated in the Hartree–Fock approximation. The energy and single-particle levels are compared with previous calculations, and some observations regarding the two-nucleon interaction are made. (auth)

11973 INELASTIC ELECTRON SCATTERING ON 4.46 AND 5.04 MeV LEVELS OF ^{11}B. Spamer, E.; Artus, H. (Technische Hochschule, Darmstadt, Ger.). Z. Phys., 198: 445-52(1967). (In German).

Using the facilities of the Darmstadt electron linear accelerator, the cross sections for the excitation of the 4.46 and 5.04 MeV level in ^{11}B were measured at various angles between 104 and 165°. The following radiation widths to the ground state (in eV) were deduced:

0.60 ± 0.09 (M1) + 0.016 ± 0.002 (E2) for the 4.46 MeV level and 1.73 ± 0.14 (M1) for the 5.04 MeV level. Transition radii were evaluated for these levels. (auth)

11974 PHOTOPRODUCTION OF ^{7}Be FROM NATURAL BORON AND BERYLLIUM. Garzon, O. L.; Rocco, G. G. (Wentworth Inst., Boston). J. Inorg. Nucl. Chem., 29: 1-6(Jan. 1967).

The nuclide ^{7}Be was produced by photoactivation of natural boron using the 23-MeV bremsstrahlung beam of an electron linear accelerator. Possible impurities of natural boron were also irradiated in order to confirm that the ^{7}Be was produced from boron. Its yield was compared with that of the $^{12}C(\gamma,n)^{11}C$ reaction at the sam energy. From threshold considerations, the most probable reaction is $^{10}B(\gamma,t)^{7}Be$. This reaction can be applied to the determination of boron at the ppM level. The integrated $^{9}Be(\gamma,2n)^{7}Be$ cross section from the threshold to 23 MeV was also estimated. (auth)

11975 STUDY OF PROTON POLARIZATION IN (d,p) REACTIONS BY THE METHOD OF TRIPLE COINCIDENCES. Skakun, N. A.; Strashinskii, A. G. Ukr. Fiz. Zh., 11: 1265-7(Nov. 1966). (In Ukrainian).

A triple-coincidence counter using two proportional counters and a thin CsI photomultiplier was used to measure the proton asymmetry in the $^{12}C(d,p)^{13}C$ reaction and the proton polarization in the $D(d,p)^{3}H$ reaction. With double-coincidence counting the background coincidences constituted 30 to 40% of the actual count. The background was reduced to 6% of the actual count with the use of triple-coincidence counting at an initial deuteron energy of 1.5 MeV. In the $D(d,p)^{3}H$ reaction the 2.04-MeV deuterons passed through a nickel foil 1.6 μ thick and struck a gaseous deuterium target. The thickness of the gas target was 55 keV for 2-MeV deuterons. The protons emitted at an angle of 39° passed through an Al foil 10 μ thick, and struck a carbon foil having a thickness of 5 mg/cm^{2}. After scattering at an angle of 45° the protons were counted by the triple-coincidence telescope. The average energy of the polarized protons was 4.95 MeV after scattering. A proton polarization of 13.6% was found. (TTT)

11976 TOTAL ABSORPTION MEASUREMENTS OF 100 TO 250 MeV PHOTONS IN CARBON AND ALUMINUM. Brookes, G. R.; Railton, R.; Rutherglen, J. G.; Smith, I. L. (Dept. of Natural Philosophy, Glasgow). Nucl. Phys., A94: 73-80(Mar. 1967).

The total cross sections for absorption of photons in carbon and aluminium were measured for photon energies of 100, 150, 200, and 250 MeV. The γ-ray bremsstrahlung beam from the 300-MeV electron synchrotron at Glasgow University was used as the source of photons. Two magnetic pair spectrometers were used as photon detectors. The results obtained are in close agreement with theoretical calculations of the total cross sections. (auth)

11977 RESONANCE AND DIRECT REACTION INTERFERENCE IN $^{12}C(d,n)^{13}N$. Fulbright, H. W. (Univ. of Rochester, N. Y.); Robbins, J. A.; West, R.; Saylor, D. P.; Verba, J. W. Nucl. Phys., A94: 214-34(Mar. 1967). (UR-875-6).

The $^{12}C(d,n)^{13}N$ reaction was studied in the region of the 4-MeV resonance. Measured excitation and angular distribution curves were analyzed on the assumption that the reaction proceeds principally in two modes (resonant and nonresonant). The total reaction amplitude is written as the sum of a stripping theory amplitude and a resonance amplitude having a Breit-Wigner denominator. Satisfactory fits to the experimental data are obtained with a resonance energy of 4.02 MeV and a level width of about 235 keV. The analysis shows that the resonant state probably has spin 1 with even parity. The relation of these results to others bearing on this level and the possible nature of the level are both discussed. (auth)

11978 PROTON NUCLEAR REACTION CROSS SECTIONS IN OXYGEN AND NEON AT 13 MeV. Chapman, R.; Macleod, A. M. (Univ. of Glasgow). Nucl. Phys., A94: 313-23(1967).

The cross sections for all reactions in oxygen and neon were measured for incident protons of 13.1-MeV energy by a triggered cloud chamber method. In oxygen the inelastic scattering, (p,α), and $(p,p'\alpha)$ cross sections were found to be 216, 39, and 118 mb, respectively, and in neon 315, 72, and 250 mb, respectively. The total reaction cross sections are 373 and 637 mb in the two cases. The oxygen results are compared with previous experiments and the total cross section is compared with optical-model predictions. There is no previous work in neon. (auth)

11979 MECHANISM OF THE $^{16}O(p,p'\alpha)^{12}C$ AND $^{20}Ne(p,p'\alpha)^{16}O$ REACTIONS AT 13 MeV. Chapman, R.; Macleod, A. M. (Univ. of Glasgow). Nucl. Phys., A94: 324-36(1967).

The mechanisms of the $^{16}O(p,p'\alpha)^{12}C$ and $^{20}Ne(p,p'\alpha)^{16}O$ reactions were studied for an incident proton energy of 13.1 MeV. It is shown that in ^{16}O about 75% of these events lead through levels in ^{13}N and the other 25% lead through levels in ^{16}O, there being no need to invoke direct interaction mechanisms. In ^{20}Ne, there is slight evidence that the reactions lead through levels in ^{16}O and ^{19}F, but firm conclusions can not be drawn in this case. (auth)

11980 ANGULAR DISTRIBUTIONS FOR THE REACTIONS $^{6}Li(d,\alpha)^{4}He$, $^{6}Li(d,p_0)^{7}Li$, AND $^{6}Li(d,p_1)^{7}Li^{*0.478}$ MeV. Bruno, G.; Decharge, J.; Perrin, A.; Surget, G.; Thibault, C. Commissariat a l'Energie Atomique, Paris). J. Phys. (Paris), 27: 517-20 (Sept.–Oct. 1966). (In French).

The angular distributions of particles from the reaction $^{6}Li(d,\alpha)\alpha$ were determined between 1 and 2 MeV by measuring the differential cross section for emission at 0°. The proton angular distributions for the reactions $^{6}Li(d,p_0)^{7}Li$ and $^{6}Li(d,p_1)^{7}Li^{*}$ were measured using the same geometry. (D.C.W.)

Nuclear Properties and Reactions, 20 ≤ A ≤ 89

Refer also to abstracts 10624, 11976, 11978, 12011, 12018, 12024, 12025, 12027, 12062, 12063, 12065, 12083, 12103, and 12114.

11981 (COO-1120-37) GAMMA-RAY SPECTRA FROM THE $^{34}S(p,\gamma)^{35}Cl$ REACTION. Tan, Yang A. (Kansas Univ., Lawrence. Nuclear Physics Lab.). [1965]. Contract AT(11-1)-1120. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The properties of the energy levels of ^{35}Cl were investigated by the $^{34}S(p,\gamma)^{35}Cl$ reaction using protons with energies up to 3 MeV. (S.F.L.)

11982 (COO–1573-6) NEUTRON TOTAL CROSS SECTION MEASUREMENTS USING A "WHITE" NEUTRON SOURCE. Galloway III, L. A.; Shrader, E. F. (Case Inst. of Tech., Cleveland, Ohio, Dept. of Physics). Sept. 1966. Contract AT-(11-1)-1573. 131p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A method for measuring neutron total cross sections using a neutron intensity spectrum continuous in energy (a "white" spectrum) and a pulsed beam time-of-flight technique is used to measure neutron total cross sections in the 2 to 10 MeV region. Total cross sections for the elements Mg, Al, Ca, V, Fe, Pd, Ag and Pb were measured to 1% average uncertainty in steps of 0.08 ns/m. Energy resolution varied from about 1.5% at 2 MeV to 3% at 10 MeV. Results of these measurements are compared with measurements on the same samples with neutrons of known energy and with measurements of other workers. (auth)

11983 (INP-491/PL) LEVEL STRUCTURE OF ^{48}Sc FROM THE $^{50}Ti(d,\alpha)^{48}Sc$ REACTION. Grotowski, Kazimierz; Wiktor, Stefan (Institute of Nuclear Physics, Krakow (Poland)). Pellegrini, Fausto (Padua Univ. (Italy). Istituto di Fisica). Oct. 1966. 14p. Dep.

The $^{50}Ti(d,\alpha)^{48}Sc$ reaction was investigated using deuterons with an energy of 12.9 MeV. The energy spectra and angular distributions of α particles emitted in this reaction were measured. Relatively large cross sections were found for transitions leading to the 0.14; 1.06; and 2.03-Mev excited states of the residual ^{48}Sc nucleus. The spin and parity values suggested for the 0.14-MeV state and the previously unobserved 1.06-MeV state are $J^{\pi} = 5^{+}$ and $J^{\pi} = 7^{+}$, respectively. (auth)

11984 (INP–502/PL) RESONANCE IN THE ELASTIC SCATTERING OF ALPHA PARTICLES ON ^{40}Ca NUCLEI. Budzanowski, Andrzej; Grotowski, Kazimierz; Jarczyk, Lucjan; Niewodniczanski, Henryk; Strzalkowski, Adam (Institute of Nuclear Physics, Krakow (Poland)). Oct. 1966. 5p. (CONF-660906–45). Dep.

From International Conference on Nuclear Physics, Gatlinburg, Tenn.

The experimental data on angular distributions for the elastic scattering of alpha particles on ^{40}Ca nuclei at different energies from 23.37 to 28.92 MeV were analyzed using the optical model. No satisfactory fits were obtained. The agreement could be considerably improved by modifying the phase shifts for the J = 10 partial waves. Evidence for a resonance at the energy of 24.4 MeV is presented. (auth)

11985 (INP-503/PL) TOTAL REACTION CROSS-SECTION FOR 24.7 MeV α PARTICLES IN THE REGION OF A = 60 NUCLEI. Budzanowski, A.; Grotowski, K.; Kuzminski, J.; Niewodniczanski, H.; Strzalkowski, A.; Sykutowski, S.; Szmider, J.; Wolski, R. (Institute of Nuclear Physics, Krakow (Poland)). Oct. 1966. 7p. Dep.

Total reaction cross sections for the interaction of alpha particles of the energy 24.7 MeV with Cr, Fe, Ni, Co, Cu, and Zn nuclei were measured by the transmission method. A good overall agreement with the predictions of the optical model was obtained with exception of Ni nuclei where the experimental value of the cross section is definitely lower than the theoretical value. (auth)

11986 (NP-16461) RESONANCES IN (p,α) AND (α,p) REACTIONS ON LIGHT NUCLEI. Kuperus, J. (Utrecht Rijksuniversiteit (Netherlands)). 1965. 70p. Dep. mn.

Thesis.

Resonances in the reactions $^{27}Al(p,\alpha)^{24}Mg$, $^{35}Cl(p,\alpha)^{32}S$, $^{37}Cl(p,\alpha)^{34}S$, $^{31}P(p,\alpha)^{28}Si$, and $^{23}Na(p,\alpha)^{20}Ne$ at 200 to 850 keV and in the reactions $^{27}Al(\alpha,p)^{30}Si$, $^{19}F(\alpha,p)^{22}Ne$, $^{31}P(\alpha,p)^{34}S$, and $^{23}Na(\alpha,p)^{26}Mg$ between 1.0 and 3.3 MeV were investigated. Resonance energies, spins, parities, strengths, and widths were obtained. (D.C.W.)

11987 (ISS-66/26) A MONTE CARLO COMPUTATION OF MULTIPLE SCATTERING EFFECTS. Biancastelli, R.; Stein, P. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). July 1966. 26p. Dep. mn.

A description and the results of a Monte-Carlo calculation of multiple scattering effects are presented. The code is written in FORTRAN IV for the IBM 7040. (auth)

11988 (NP-16393) A STUDY OF SOME (^{3}He,n) REACTIONS. Van der Merwe, Philip (Cape Town Univ. (South Africa)). Sept. 1966. 157p. Dep. mn.

Thesis.

A time-of-flight neutron spectrometer incorporating pulse-shape discrimination is described. Using this spectrometer, and a pulsed ^{3}He beam, measurements were made on the neutron groups from the following reactions: (1) $^{24}Mg(^3He,n)^{26}Si$, (2) $^{28}Si(^3He,n)^{30}S$, (3) $^{32}S(^3He,n)^{34}Ar$ and (4) $^6Li(^3He,n)^8B$. The ^{3}He bombarding energies varied from 4.2 to 5.6 MeV. The ground state Q-values were measured, and previously unobserved low-lying energy levels were determined in some of the final nuclei. The ground-state Q-value for the $^{32}S(^3He,n)^{34}Ar$ reaction yields a mass value for the new isotope ^{34}Ar. There is a close correspondence between some of the new levels reported here and analogous states in the A = 26, 30, and 34 isobaric triplets. Angular distributions and cross sections were measured for several neutron groups from the above-mentioned reactions. Simultaneous angular distribution measurements were also made on the neutron groups from the $^{12}C(^3He,n)^{14}O$ and $^{16}O(^3He,n)^{18}Ne$ reactions. The results of all the measured distributions indicate a predominant direct reaction mechanism. The results are compared with the predictions of PWBA and DWBA theories. While reasonable agreement is obtained, some features of the angular distributions can not be accounted for by the simple double stripping theories. The combined evidence of isobaric analog states and angular distributions enable J^π to be assigned to some of the levels observed. From the reaction $^6Li(^3He,n)^8B$, a single excited state was determined in ^{8}B. The width of this state (which is unbound was measured. The ground-state reaction is shown to proceed at least partially via an exchange-type (forward knock-out) mechanism. A continuum neutron spectrum is observed from the ^{3}He bombardment of ^{6}Li. A probable origin for this continuum is discussed. (auth)

11989 (NYO-72-107) CINDA: AN INDEX TO THE LITERATURE ON MICROSCOPIC NEUTRON DATA. (Columbia Univ., New York. ENEA Neutron Data Cimpilation Centre, Gif-sur-Yvette (France)). July 1, 1966. Contract AT-30-1-GEN-72. 138p. (EANDC-60(U); CCDN-CI-11). DTI Extension.

A cumulative bibliography is given of the literature on microscopic neutron cross sections and allied data. The material is arranged in order of the target nucleus and by the type of data referenced. Coverage is generally limited to scattering and reactions induced by neutrons of energy <20 MeV, for specific elements and isotopes. Information on (γ,n) and (γ,f) reactions has been included for cases in which the γ-ray energy is less than ~15 MeV and the (γ,n) cross section greater than 0.1 mb. While most of the references covered report on measurements, CINDA also includes theoretical calculations, cross section evaluations, and compilations insofar as they refer to specific target nuclei. (S.F.L.)

11990 (UCD-34P75-1) NUCLEAR REACTIONS AT HIGH ENERGIES. Final Report. Warren, John (California Univ., Davis). May 15, 1966. Contract AT(11-1)-34. 31p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The isobaric cross-section ratios $^{45}Ti/^{45}Ca$, $^{48}Cr/^{48}V$, $^{52}Fe/^{52}Mn$, $^{55}Co/^{55}Fe$, and $^{56}Ni/^{56}Co$ from alpha and proton reactions in Cu foils at 310 to 880 MeV and 230 to 760 MeV, respectively, were measured. Excitation functions were measured for the production of Co isotopes including ^{58m}Co and ^{58g}Co, in alpha and proton reactions in Co foils at 330 to 880 MeV and 100 to 720 MeV, respectively. Secondary reactions produced in Cu foils by alpha particles of 330 to 880 MeV and protons of 270 to 730 MeV were also investigated. Apparent cross sections for the production of ^{71}As, ^{72}As, and ^{69}Ge were determined. At proton energies of 270, 500, and 730 MeV and at an alpha energy of 330 MeV, the cross sections were studied as a function of target thickness. (D.C.W.)

11991 (UCOL-535-561) TECHNICAL PROGRESS REPORT [ON NUCLEAR PHYSICS]. (Colorado Univ., Boulder. Dept. of Physics and Astrophysics). Nov. 1, 1966. Contract AT(11-1)-535. 70p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The optical-model potential was investigated using ^{3}He scattering by medium-weight nuclei. Angular distributions for the reaction $^{12}C(He-3,\alpha)^{11}C$ and for ^{3}He elastic scattering by ^{12}C at 43.7 MeV were analyzed using the optical model and the DWBA formalism. Angular distributions for proton inelastic scattering by ^{92}Zr and ^{94}Zr were fitted using distorted-wave theory and shell-model form factors. Angular distributions for the $^{96}Zr(p,d)^{95}Zr$ reaction and for proton inelastic scattering by ^{96}Zr at 19.4 MeV were measured and were calculated; spectroscopic factors were obtained by a distorted-wave analysis of the $^{96}Zr(p,d)^{95}Zr$ reaction. Level density fluctuations in ^{58}Fe were investigated using proton inelastic scattering, and proton elastic and inelastic scattering by ^{42}Ca and ^{44}Ca at 22.9 MeV was studied experimentally and theoretically. Energy levels in ^{35}Ar, ^{36}K, and ^{37}K were investigated using the reactions $^{36}Ar(p,d)^{35}Ar$, $^{36}Ar(He-3,t)^{36}K$, and $^{36}Ar(He-3,d)^{37}K$. The Coulomb energy systematics of isobaric triplets in the mass region $22 \leq A \leq 40$ were also investigated experimentally. The proton elastic scattering cross section of ^{58}Ni was calculated using a modified optical theorem, and optical-model parameters were investigated using proton elastic scattering by ^{40}Ar, ^{209}Bi, ^{208}Pb, ^{58}Ni, ^{14}N, ^{16}O, ^{116}Sn, and ^{96}Zr. Information on the level structure of ^{88}Sr and ^{89}Y was obtained from angular distributions for proton scattering by ^{88}Sr and ^{89}Y at 19.5 MeV and for the reaction $^{88}Sr(He-3,d)^{89}Y$ at 37.7 MeV. Proton elastic and inelastic scattering by ^{56}Fe, ^{57}Fe, and ^{58}Fe at 22.5 MeV was also investigated; experimental angular distributions were fitted using the optical model. The (d,p), (p,d), and (He-3,d) reactions on ^{40}Ca were investigated using optical-model wave functions obtained from proton and deuteron elastic scattering by ^{40}Ca; previously unreported levels of ^{39}Ca and ^{41}Sc were observed. Previously unreported levels of ^{57}Ni, ^{88}Y, and ^{89}Zr were observed in a study of the reactions $^{58}Ni(He-3,\alpha)^{57}Ni$, $^{89}Y(He-3,\alpha)^{88}Y$, and $^{90}Zr(He-3,\alpha)^{89}Zr$. A method of measuring the half lives of long-lived radioisotopes was developed; the half lives of ^{36}Cl and ^{41}Ca were measured. Techniques for the fabrication of Ge(Li) detectors were also investigated. (D.C.W.)

11992 (UCRL-50185) A RECIPE FOR GAMMA RAY PRODUCTION CROSS SECTIONS FOR NUCLIDES WITH A ≥ 20, ASSOCIATED WITH 4 TO 14 MeV NEUTRON INDUCED REACTIONS. Howerton, Robert; Plechaty, Ernest (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 11, 1967. Contract W-7405-eng-48. 87p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A formalism for the calculation of gamma production cross sections as a function of energy and a gamma spectrum for each cross section is presented, together with the results of some sample calculations. (D.C.W.)

11993 FAST NEUTRON RADIATIVE CAPTURE BY ^{89}Y. Tolstikov, V. A.; Koroleva, V. P.; Kolesov, B. E.; Dovbenko, A. G. At. Energ. (USSR), 21: 506-7(Dec. 1966). (In Russian).

A relative activation method was used for measuring cross sections of radiative capture of 0.16- to 3.6-MeV neutrons by ^{89}Y. The determination of ^{89}Y radiative capture cross sections was based on the following data: the cross sections of thermal neutron capture by ^{89}Y with the activity $T_{1/2}$ = 64.4 hr equal to 1.26 ± 0.08 barn, cross sections of ^{235}U thermal neutron fission equal to 577.1 ± 0.9 barn, and the cross sections for ^{235}U fast neutron fission. The cross sections of radiative capture of ^{89}Y were computed using the statistical theory of nuclear reactions. The cross section curves constructed for the radiative neutron capture $^{89}Y(n,\gamma)^{90}Y$ were compared with theoretical and published data. (R.V.J.)

11994 THE DECAY OF ^{83}Rb. Kitching, J. E.; Johns, M. W. (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 44: 2661-83 (Nov. 1966).

The decay of 14.9-minute ^{83}Rb to levels in ^{83}Sr was studied by use of Ge(Li) detectors, NaI(Tl) detectors, and a magnetic beta-ray spectrometer. Fourteen gamma rays were studied by γ-γ and β-γ coincidence experiments and establish levels at 0, 1.031, 2.000, 2.277, 2.567, 2.708, 2.770, 3.225, and 3.500 MeV. The Q value is 4.486 ± 0.012 MeV. The γ-γ and β-γ data were analyzed by a nonlinear least-squares fitting technique, which is described. (auth)

11995 GAMMA-RAY SPECTRAL UNFOLDING BY THE STEPWISE STATISTICAL METHOD. Young, M. H. (Louisiana State Univ., Baton Rouge); Singhal, N. S. Nucl. Instrum. Methods, 45: 287-92(1966).

The principle of the stepwise statistical method is applied to the gamma-ray spectral analysis of a mixture of several radionuclides. During the multiple regression procedure the F-level tests are given sequentially for entering and removing the nuclides from a

set of library spectra. The spectrum is unfolded when a best-fit is obtained. The computer program is written in FORTRAN 4 language for the IBM 7040 computer and has the capacity to resolve a mixture containing up to 99 nuclides. Provisions are made to correct the spectrometric gain settings and the channel drift by employing the calibration sources at each run. The flexibility of data gathering and the advantages of the stepwise principles make this method suitable for experimental analysis of mixed gamma spectra. (auth)

11996 GAMMA-RAY BRANCHING FROM THE ^{49}Ca GROUND-STATE ANALOG IN ^{49}Sc. Chasman, C.; Jones, K. W.; Ristinen, R. A.; Sample, J. T. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 18: 219-23(Feb. 6, 1967). (BNL-10707).

Gamma rays from the reaction ^{48}Ca(p,γ)^{49}Sc were observed at proton energies corresponding to formation of the ^{49}Ca ground-state analog. Gamma intensities were measured and anomalous behavior is observed. (auth)

11997 THE DECAY OF ^{62}Zn. Roulston, K. I.; Becker, E. H.; Brown, R. A. (Univ. of Manitoba, Winnipeg). Phys. Lett., 24B: 93-4(Jan. 23, 1967).

Several previously unreported gamma rays, including a pair at 243.7 and 247.2 keV, were found in the spectrum of ^{62}Cu, following decay of ^{62}Zn, using a high-resolution Ge(Li) detector. A revised scheme, with five excited states, is proposed. (auth)

11998 HIGH RESOLUTION MEASUREMENTS OF ISOBARIC ANALOGUE STATES BY THE NEUTRON TIME-OF-FLIGHT METHOD. Arai, E.; Miessner, H. (Kernforschungszentrum, Karlsruhe, Ger.). Phys. Lett., 24B: 84-6(Jan. 23, 1967).

The neutron time-of-flight method was used to investigate the ^{59}Co(p,n)^{59}Ni cross section. The cross section shows a fine structure superimposed on a gross structure; the peaks of the latter are interpreted as analog states of ^{60}Co in ^{60}Ni. An additional ^{59}Co(p,γ)^{60}Ni cross-section measurement served as a check and was also used to determine the Coulomb displacement energy. (auth)

11999 THE DECAY OF ^{82}Br. Hsu, F. H. H.; Wu, C. S. (Columbia Univ., New York). Nucl. Phys., A94: 205-13(Mar. 1967).

The decay scheme of ^{82}Br was reinvestigated with a Ge(Li) detector. A total of 11 weak gamma rays were observed in addition to the eight well-known ones. Time coincidences were established for the following cascades: 222-1650-777, 1008-1044, and 606-1044 keV gamma rays. Possible spin assignment of 3^+ or 4^+ to the newly established energy level at 2426 keV was obtained through angular correlation measurements between 1650-777 keV gamma rays. The peaks at 1650, 1778, and 1955 keV were shown to be the gamma rays of ^{82}Br. The peak at 1868 keV is due to true coincidence summing effect. No peak at 2057 keV was observed. (auth)

12000 A STUDY OF THE SPIN DEPENDENCE OF THE NUCLEAR LEVEL DENSITY BY MEANS OF THE ^{89}Y(n,γ)^{90g,90m}Y REACTIONS WITH FAST NEUTRONS. Grench, H. A.; Coop, K. L.; Menlove, H. O.; Vaughn, F. J. (Lockheed Palo Alto Research Lab., Calif). Nucl. Phys., A94: 157-76(Mar. 1967).

The ^{89}Y(n,γ)^{90m}Y and ^{89}Y(n,γ)^{90g}Y cross sections were determined at 12 neutron energies between 0.14 and 1.22 MeV. Neutrons were produced by the ^{7}Li(p,n)^{7}Be reaction. The full neutron energy spread was about 65 keV. The activation cross sections were measured relative to both the ^{235}U(n,f) cross section and the ^{197}Au(n,γ)^{198}Au activation cross section. The results for the isomer ratios were compared with the predictions of the statistical theory of nuclear reactions together with a Fermi gas, level-spacing formula in order to obtain the spin cut-off factor σ in the spin dependence of the nuclear level density. The effects of variations in the parameters in the theory have been studied. Very good agreement was obtained with σ = 3.3, assuming a γ-ray multiplicity of 4. The ^{89}Y(n,γ)^{90m}Y cross section was also measured at 14.8 MeV to be 0.50 ± 0.07 mb. Finally, the half life of ^{90m}Y was found to be 3.19 ± 0.01 hr. (auth)

12001 SHELL-MODEL CALCULATION IN ^{24}Mg. Wathne, K. (Univ. of Oslo); Engeland, T. Nucl. Phys., A94: 129-45(Mar. 1967).

A shell-model calculation was performed for ^{24}Mg assuming wave functions with maximum symmetry in the spacial coordinates. Several interactions were used including the Kallio-Kolltveit hard-core potential. A reasonable agreement is obtained for the energy levels, while the E2 branching ratios are in many cases different from the experimental values. The eigenfunctions have large overlap with the predicted SU_3 wave functions. The influence of particle-hole excitations in the spectrum is discussed. (auth)

12002 ORBITAL ELECTRON CAPTURES IN ^{57}Co AND THE K-FLUORESCENCE YIELD OF IRON. Mukerji, Ambuj; McGough, James B. Jr. (Univ. of Alabama, University). Nucl. Phys., A94: 95-102(Mar. 1967).

The ratio of rate of production of K X-rays to the total electron capture rate in ^{57}Co was determined by measuring the K x-ray-122-keV gamma ray and the 122-keV gamma ray-14.4-keV gamma coincidence rates simultaneously using a proportional counter for the detection of the low-energy radiations. The value of the K-fluorescence yield of iron ω_K was obtained by comparing these data with the theoretical corrected ratio of K-capture rate to the rate of capture from all the shells, and the value of ω_K obtained this way is ω_K = 0.322 ± 0.029. (auth)

12003 MASSES AND EXCITATION ENERGIES OF SOME PROTON-RICH NUCLEI. Miller, Richard G.; Kavanagh, R. W. (California Inst. of Tech., Pasadena). Nucl. Phys., A94: 261-88(1967).

The Q-values for seven (^{3}He,n) reactions were measured, using a silicon semiconductor detector as a fast-neutron spectrometer, with the following results (final nuclei, Q-values in keV): ^{26}Si, 85 ± 18; ^{30}S, -573 ± 15; ^{34}Ar, -579 ± 15; ^{42}Ti, -2865 ± 6; ^{46}Cr, 5550 ± 18; ^{58}Ni, 4513 ± 14; and ^{60}Zn, 818 ± 18. The following excited states (excitation energies in MeV) were also seen: ^{26}Si, 1.79, 2.80; ^{30}S, 2.19; ^{34}Ar, 2.06; ^{46}Cr, 0.72?, 2.37?; ^{58}Ni, 2.69, 3.95, 6.60; and ^{60}Zn, 1.02. Rough measurements of the 0°(^{3}He,n) cross sections are given. Neutron angular distributions for ^{28}Si(^{3}He,n) to the ground and first excited states of ^{30}S are consistent with assignments of 0^+ and 2^+. Two gamma rays observed with energies 1.28 ± 0.06 and 2.66 ± 0.1 MeV are attributed to the reaction ^{54}Fe(^{3}He,nγ)^{56}Ni. The (^{3}He,p) Q-values of nuclear reactions forming ^{48}V, ^{56}Co and ^{60}Cu were measured with a magnetic spectrometer. Ground-state Q-values for ^{56}Co and ^{60}Cu are 7410 ± 10 keV and 5770 ± 12 keV. Many excited states were seen, viz. ^{48}V(3), ^{56}Co(15), and ^{60}Cu(23). (auth)

12004 STUDIES IN THE DECAY OF ^{62}Zn. Antman, S.; Pettersson, H.; Suarez, A. (Inst. of Physics, Uppsala). Nucl. Phys., A94: 289-300(1967).

The decay of ^{62}Zn to ^{62}Cu was studied using a double-focusing iron-yoke beta spectrometer for the electron and positon spectra and a Ge(Li) solid-state detector for the gamma ray measurements. Energies and relative intensities were deduced from the spectra for the gamma transitions and conversion lines belonging to the decay. A level scheme for ^{62}Cu with spin and parity assignments is given. (auth)

12005 g-FACTOR OF THE 305-keV STATE OF ^{48}V. Auerbach, K. (Univ., Hamburg); Braunsfurth, J.; Maier, M.; Bodenstedt, E.; Flender, H. W. Nucl. Phys., A94: 427-41(1967).

The g-factor of the 305-keV state of the doubly odd nucleus ^{48}V was determined by observing the rotation of the 116 keV-305 $\gamma\gamma$ angular correlation in strong external magnetic fields. Liquid sources as well as ^{48}Cr sources embedded in the lattice of metallic copper were used for these measurements. A slight attenuation of the angular correlation was found for the liquid source, whereas the metallic source seemed not to produce an attenuation. Within the limits of error of this experiment the same rotation was found for both sources. The result is discussed in the framework of the shell model as well as in the Nilsson model. The half life of the 305-keV state was redetermined to be 7.09 ± 0.07 nsec. The 116 keV-305 keV $\gamma\gamma$ angular correlation confirms the previous spin and mutlipolarity assignments. (auth)

12006 ELASTIC SCATTERING OF 7 TO 9 MeV PROTONS BY ^{89}Y. Brady, F. P.; Draper, J. E.; McCray, J. A. (Univ. of California, Davis). Nucl. Phys., A94: 449-56(1967).

Measurement and analysis of proton elastic scattering on ^{89}Y are reported for lab energies of 7.44, 8.08, and 9.01 MeV. The results were analyzed with the optical model using the average parameters of Rosen employed for analysis of proton elastic scattering, polarization, and reaction cross sections for many nuclides. The fit is satisfactory but is improved by a 2 to 3 MeV (4 to 6%) increase of the real central potential and a 1 to 2 MeV decrease in the imaginary potential. The potential parameters from a best-fit search are also listed. (auth)

12007 ISOMERIC CROSS-SECTION RATIOS FOR (n,2n) REACTIONS AT 14.8 MeV. Prasad, R.; Sarkar, D. C. (Muslim Univ., Aligarh, India). Nucl. Phys., A94: 476-80(1967).

Isomeric cross-section ratios for (n,2n) reactions at 14.8 MeV were measured for the isomeric pairs ^{34m,34}Cl, ^{44m,44}Sc, ^{91m,91}Mo, and ^{114m,114}In. Using the compound nuclear mechanism the spin distribution form due to Bethe and Bloch, theoretically calculated isomeric ratios were compared with the measured values to find the probable value of the spin distribution parameter σ. The parameter was also calculated from the rigid moment of inertia of the nucleus. (auth)

12008 STUDY OF (n,p) REACTIONS ON THE ISOTOPES ^{74,76,78}Se AT THE NEUTRON ENERGY E_n = 14.7 MeV. Ivanenko,

V. V.; Bugorkov, S. S.; Petrzhak, K. A.; Sorokina, A. V. Yadern Fiz., 4: 1162-4(Dec. 1966). (In Russian).

Energy and angular distributions of high-energy protons emitted in (n,p) reactions on the isotopes ^{74}Se, ^{76}Se, and ^{78}Se were investigated. The angular anisotropy with the dominating proton emission into the forward hemisphere was found for every isotope. The anisotropy increases with the isotope mass number which indicates the increasing contribution from the direct-interaction processes. (auth)

12009 ANGULAR DISTRIBUTION OF 0.3-, 0.5-, AND 0.8-Mev NEUTRONS ELASTICALLY SCATTERED BY TITANIUM AND COBALT NUCLEI. Korzh, I. A.; Mishchenko, V. A.; Pravdiyi, N. N.; Prikhodko, V. P.; Sklyar, M. T.; Totskii, I. A. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 11: 563-5(1966). (In Ukrainian)

In view of the absence of sufficient data on the angular distribution of elastically scattered neutrons with energies below 1 MeV, measurements were carried out to determine these values and the differential cross section of 0.3 and 0.5-MeV neutrons elastically scattered by titanium nuclei and of 0.5- and 0.8-MeV neutrons elastically scattered by cobalt nuclei. The T(p,n)^{3}He reaction served as the neutron source; and a methane-filled proportional counter was used as the neutron detector. The titanium scatterer consisted of a 3-cm diameter metallic ball while a 3-cm diameter spherical copper container filled with powdered metal served as the cobalt scatterer. A boron neutron-flux monitor was placed at a 60° angle with respect to the proton beam. The experimentally obtained angular distribution data were plotted; they were found to be in good agreement with previous data. The theoretical and measured cross-section data also agreed with each other. (TTT)

12010 ^{40}Ar(d,p) EXCITATION FUNCTIONS OVER THE GROUND-STATE ISOBARIC ANALOG ENERGY REGION. Wilhjelm, P. (Univ. of North Carolina, Chapel Hill. Duke Univ., Durham, N. C.); Keyworth, G. A.; Kyker, G. C. Jr.; Sellin, D. L.; Roberson, N. R.; Bilpuch, E. G. Phys. Rev. Lett., 18: 130-2 (Jan. 23, 1967).

Excitation functions for eight proton groups from the reaction ^{40}Ar(d,p)^{41}Ar were measured between 2.5 and 3.1 MeV in attempt to observe the formation of analog states of ^{41}K. Spin and parity assignments were made for several levels in ^{41}Ar. Anomalous behavior of the excitation functions, corresponding to the formation of analog states, was observed. (D.C.W.)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 10624, 10673, 11920, 11921, 11950, 11956, 11982, 11987, 11989, 11991, 11992, and 11995.

12011 (AECL-2639) PHYSICS DIVISION. Progress Report, July 1-September 30, 1966. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). 71p. (PR-P-71). Dep. mn. AECL $2.00.

The cross sections for excitation of energy levels in ^{19}F by the scattering of 14-MeV neutrons were measured. The anisotropy of fission fragments from ^{238}U(d,pf) and ^{239}Pu(d,pf) near threshold was investigated. Studies were made of ternary fission of ^{252}Cf in which a long range α-particle accompanies the emission of the two large fragments. The ^{12}C(^{12}C,$\alpha\gamma$)^{20}Ne reaction at a ^{12}C ion energy of 21.35 MeV was used to study the 10.65-MeV level in ^{20}Ne. Lifetimes of levels in ^{28}Si were obtained by Doppler-shift attenuation measurements. In preparation for use with the MP tandem accelerator, the broad-range magnetic spectrograph was modified to permit the study of particles emitted at 180° with respect to the incident beam direction, in addition to the usual angular range of 0 to 165°. An experiment based on the (d,pγ) reaction was conducted to investigate statistical aspects of the gamma spectra of a number of medium and heavy elements. The L subshell ratios of the 162.65-keV transition in ^{140}La are being investigated with a $\pi\sqrt{2}\,\beta$ spectrometer. The properties of the 57- and 350-keV states in ^{143}Pr are being studied. Magnetic moments of excited states in ^{169}Tm are being investigated by $\gamma-\gamma$ cascade angular-correlation measurements. To aid in the interpretation of these measurements, the conversion-electron spectrum of ^{169}Yb is being studied in the $\pi\sqrt{2}\,\beta$ spectrometer at resolutions of 0.03 to 0.1% in momentum. Extensions to the efficiency tracing method for eliminating self-absorption errors in $4\pi\,\beta$ counting were studied. Neutron counters filled with ^{3}He up to 8 atm of pressure were developed. Studies were made of the performance of large-volume coaxial Ge(Li) detectors operated with low-noise field-effect-transistor-type amplifiers. The performance of planar-type Ge(Li) detectors was investigated at different temperatures ranging from 4.2 to 150°K. The normal modes of vibration in large $NaNO_2$ crystals are being studied. Measurements were made of the magnetic excitations of UO_2 in the [111] direction of propagation from nuclear lattice points. The ferroelectric and semiconducting properties of SnTe-GeTe alloys are being investigated with the possibility of developing new electromechanical transducers. A triple-axis crystal spectrometer was used to measure magnetic excitations between the lowest two electronic states of the Co^{++} ion in CoF_2. Measurements were made of the energy distribution of 2.3 Å neutrons scattered from a powdered sample of Er metal at room temperature using a rotating-crystal spectrometer. Calculations are being made of the widths and shifts of phonons in K as a function of temperature. The anharmonic coefficients which determine these quantities are obtained from a pseudopotential fitted to phonon frequencies at 9°K. Gamma energies from ^{96}Mo and ^{98}Mo following the reactions ^{95}Mo(n,γ)^{96}Mo and ^{97}Mo(n,γ)^{98}Mo were measured using a coaxial Ge(Li) detector. Resonance scattering measurements on natural lead were made using the Compton scattered 8.99-MeV neutron capture γ rays of nickel for excitation. An energy range of 6.6 to 8.0 MeV was investigated. A relation was found between cold-neutron scattering by simple molecular liquids and the corresponding infrared and Raman spectra of these substances. For liquids in which statistical correlations between the rotational and translational motion are negligible, the contribution of the rotational motion to the cold-neutron scattering cross sections can be obtained from the infrared and Raman rotational-vibrational line shape functions. Coherent scattering of neutrons by liquids was theoretically investigated. A study is being made of the effect of pairing forces on the energy of the ground-state band in ^{20}Ne. The structure of states in ^{28}Si was studied by including a spin-orbit force in the Hartree-Fock treatment of the nucleus. Using the three-body formalism of Faddeev and a separable-potential approximation to the two-body interactions, several three-body nuclear systems are being investigated. The electro- and photodisintegration of ^{3}He was theoretically investigated. (S.F.L.)

12012 (COO-1573-5) THE NUCLEAR g-FACTORS OF THE FIRST EXCITED STATES IN 152 AND 154 SAMARIUM AND 156, 158, AND 160 GADOLINIUM. Wolfe, P. J.; Scharenberg, R. P. (Case Inst. of Tech., Cleveland, Ohio. Dept. of Physics). [1965]. Contract AT(11-1)-1573. 172p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The nuclear g-factors of the first excited rotational states in ^{152}Sm and ^{154}Sm and ^{156}Gd, ^{158}Gd, and ^{160}Gd were measured using the pulsed-beam technique. The precession of the Coulomb-excited nuclei in an external magnetic field was detected by observing the de-excitation gamma radiation as a function of time. The measured g-factors and mean lives (τ) were g = 0.277 ± 0.028 and τ = 2.12 ± 0.06 ns for ^{152}Sm; g = 0.287 ± 0.029 and τ = 4.37 ± 0.13 ns for ^{154}Sm; g = 0.296 ± 0.018 and τ = 3.29 ± 0.08 ns for ^{156}Gd; g = 0.292 ± 0.026 and τ = 3.69 ± 0.09 ns for ^{158}Gd; and g = 0.303 ± 0.026 and τ = 3.92 ± 0.09 ns for ^{160}Gd. Samarium and gadolinium ions are paramagnetic, and the magnetic field at the nucleus is altered by the effects of the electron shell. For ^{152}Sm the effective g-factor was measured as a function of temperature to test the accuracy of internal-field calculations. There were significant deviations from the calculated internal field above room temperature. The samarium-metal targets were noticeably perturbed by electric quadrupole interactions. The gadolinium targets were liquid metals, and no perturbations were observed. (auth)

12013 (EANDC(OR)-44(L)) PROGRESS REPORT TO E.A.N.D.C. FROM SWEDEN, MARCH 1966. Starfelt, N. (ed.) (Aktiebolaget Atomenergi, Studsvik (Sweden)). 16p. Dep. mn.

The research progress and programs at the Swedish facilities are summarized. Studies of neutron emission in the fast-neutron fission of ^{241}Pu; neutron resonance radiative capture cross sections of 2s1d shell nuclei; neutron angular distributions from (p,n) reactions on ^{9}Be and ^{7}Li; fast-neutron attenuation in natural U and masonite; cold-neutron scattering by n-propyl alcohol; the effects of fast neutrons on single crystals of Al; the energy levels of ^{155}Eu, ^{179}Hf, ^{161}Tb, and ^{177}Yb transitions in deformed nuclei; the levels of ^{163}Dy and ^{166}Ho; the decay of ^{149}Nd and ^{182}Ta to ^{149}Pm and ^{182}W, respectively; fast-neutron scattering by Co, Fe, and ^{57}Fe; the scattering of polarized fast neutrons by Cu, Pb, and Mo; and neutron angular distributions and spectra from (p,n) reactions on ^{42}Ca, ^{44}Ca, ^{50}Cr, ^{54}Fe, and ^{31}P are briefly covered. (D.C.W.)

12014 (IN-1015) TABULATION OF THE TOTAL NEUTRON CROSS SECTION OF ^{232}U. Simpson, O. D.; Moore, M. S.; Berreth, J. R. (Idaho Nuclear Corp., Idaho Falls). Dec. 1966. Contract AT(10-1)-1230. 69p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The total neutron cross section of ^{232}U was measured from 0.01 to 10,000 eV using the Materials Testing Reactor (MTR) fast chopper. A 2200 meter/sec total neutron cross section of 165 ± 10 barns was determined. Multilevel parameters are listed for res-

onances below 30 eV. Results of the analysis indicate that two fission channels are needed to describe the experimental data. A tabulation of the data is given. (auth)

12015 (IN–1040) TABULATION OF THE ^{228}Th TOTAL NEUTRON CROSS SECTIONS FOR THE 1.9 AND 7.5 eV RESONANCES. Simpson, O. D.; Schuman, R. P.; Berreth, J. R. (Idaho Nuclear Corp., Idaho Falls). Dec. 1966. Contract AT(10-1)-1230. 16p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The total neutron cross section of ^{228}Th was measured in the regions of 1.9 and 7.5 eV, using the Materials Testing Reactor fast chopper. Breit-Wigner single level resonance parameters are given for the two resonances observed. (auth)

12016 (INP–481/PL) NEWLY OBSERVED GAMMA TRANSITIONS IN ^{151}Tb AND ^{152}Tb DECAYS. Kormicki, J.; Niewodniczanski, H.; Stachura Z.; Zuber, K.; Budziak, A. (Institute of Nuclear Physics, Krakow (Poland)). June 1966. 33p. Dep.

The internal conversion-electron spectrum of the decays of ^{151}Tb and ^{152}Tb in the energy range from 30 to 600 keV was measured using a semicircular beta spectrograph. The activities were produced by spallation of Ta nuclei with 660-MeV protons. The energies and relative intensities of conversion lines were measured. For some transitions, the multipolarities and mixing ratios were also determined. Twelve gamma transitions in ^{151}Gd and ^{152}Gd nuclei based on a number of newly observed conversion lines in the ^{151}Tb and ^{152}Tb decays were determined for the first time. (auth)

12017 (INR-755/IA/PL) ON THE SPIN ASSIGNMENT OF NEUTRON RESONANCES IN ^{149}Sm USING (n,α) REACTION. Dakowski, M.; Krogulski, T.; Piasecki, E.; Piekars, H.; Sowinski, M. (Institute of Nuclear Research, Warsaw (Poland)). Sept. 1966. 15p. Dep.

Cross sections for the reaction ^{149}Sm(n,α)^{146}Nd were measured using thermal neutrons and a 99% enriched ^{149}Sm target. The results were compared with theoretical cross sections calculated using the compound-nucleus and statistical models. The experimental and theoretical values are consistent only when the spins of the bound state and the 0.0967-eV resonance in ^{149}Sm + n are assumed to be 3^- and 4^-, respectively. (D.C.W.)

12018 (INSJ–101) LOW-LYING ENERGY LEVELS IN EVEN–EVEN NUCLEI. Ejiri, Hiroyasu (Institute for Nuclear Study, Tokyo Univ. (Japan)). Oct. 28, 1966. 39p. Dep. mn.

The low-lying levels of medium-weight and heavy nuclei were investigated; some systematic features of the levels were noted. A simple formula with one parameter reproduces quite well the observed energy as a function of spin of the ground bands in all nuclei except singly and doubly closed shell nuclei. (D.C.W.)

12019 (JINR–E7-3043) ON SPONTANEOUS FISSION OF ISOTOPE 102^{254}. Flerov, G. N.; Kuznetsov, V. I.; Skobelev, N. K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1966. 7p. Dep. mn.

Spontaneous fission of the isotope ^{254}No was investigated in the reaction ^{238}U (^{22}Ne,6n)^{254}No. The experiments performed showed that the period of spontaneous fission of ^{254}No is not less than 25 hours. Experiments were made with an internal beam of the JINR LNR 310-cm cyclotron. (auth)

12020 (JINR–P-2915) ISSLEDOVANIE IZLUCHENIYA ^{151}Tb. (Investigation of ^{151}Tb Irradiation). Vil'skii, K.; Kuznetsov, V. V.; Nil'sen, O. B.; Skilbrait, O.; Khalkin, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1966. 18p. (In Russian). Dep. mn.

A conversion electron spectrum and γ-ray and e-γ coincidence spectra of ^{151}Tb were investigated. The γ spectrum was investigated by using a Ge(Li) semiconductor detector with dimensions 0.7 cm^2 × 0.35 cm with a 1024-channel pulse-height analyzer. Conversion electron spectra and e-γ coincidence spectra were investigated with a six-gap β spectrometer by using a 512-channel pulse-height analyzer with a NaI(Tl) detector (7.6 cm^2 × 7.6 cm). The ^{151}Tb was obtained with the help of a mass separator from the Tb fraction. The Tb fraction was obtained by chromatographic separation of the rare earth elements extracted from Ta, which was bombarded with 660-MeV protons in the internal beam of the JINR synchrocyclotron. On the basis of the energy balance, γ-ray spectrum analysis, and e-γ coincidences as well as the intensity balance, the ^{151}Tb → ^{151}Gd decay mode is suggested. The electron capture population ^{151}Gd levels and the values of log ft were determined. (auth)

12021 (JINR-P7-2984) ISSLEDOVANIE 1,4-MINUTNOGO SPONTANNO DELYASHCHEGOSYA PRODUKTA V REAKTSII ^{230}Th + ^{10}B. (Investigation of the Spontaneously Fissionable Product ($T_{\frac{1}{2}}$ = 1.4 min) in ^{230}Th + ^{10}B Reaction). Kuznetsov, V. I.; Skobelev, N. K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1966. 6p. (In Russian). Dep. mn.

A curve is obtained of the yield of a nucleus which emits fission fragments with a half life equal to 1.4 min, when bombarding ^{230}Th with ^{10}B ions. It is supposed that with such a half life the fission of ^{232}Am from an isomeric state produced in the reaction ^{230}Th (^{10}B,8n) takes place, or that the delayed fission of ^{232}Pu from an excited state after electron capture of ^{232}Am is observed. (auth)

12022 (JINR–P7-3063) DELENIE YADER TYAZHELYMI IONAMI NA TRI OSKOLKA. (Ternary Fission of Nuclei Induced by Heavy Ions). Karamyan, S. A.; Kuznetsov, I. V.; Oganesyan, Yu. Ts.; Penionzhkevich, Yu. E. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1966. 17p. (In Russian). Dep. mn.

Fission into three fragments of approximately equal mass was observed while bombarding ^{197}Au, ^{209}Bi, and ^{238}U with 8-MeV/nucl. ^{22}N and ^{40}Ar ions. Semiconductor surface-barrier detectors were used to record the ternary fission. The experimental results can be explained by the mechanism of cascade fission of an excited nucleus when an iterative fission of a heavy fragment accompanies an asymmetrical binary fission. (auth)

12023 (NP–16440) REVIEW OF THE PUBLISHED VALUES OF THE NUMBER OF NEUTRONS EMITTED IN THE FISSION PROCESS. Asplund-Nilsson, I. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Mar. 1963. 48p. Dep. mn.

A collection of $\bar{\nu}$-values is given for spontaneous and neutron-induced fission of different fissile isotopes. It contains values published up to July 1, 1962. (auth)

12024 (NYO–2771-19) NUCLEAR CHEMISTRY RESEARCH: RECOIL STUDIES OF NUCLEAR REACTIONS. Annual Report, January 1966–January 1967. Wolke, Robert L. (Pittsburgh Univ., Pa. Wherrett Lab. of Nuclear Chemistry). Contract AT(30-1)-2771. 76p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The compound-statistical features of deuteron-induced reactions were studied further. The cross section of the ^{65}Cu(d,2p)^{65}Ni reaction was measured using 12-MeV deuterons, and a computer program was written for statistical-model evaporation calculations. In addition, absolute cross sections and isomeric yields ratios for (d,p) reactions on ^{114}Cd, ^{133}Cs, ^{59}Co, ^{110}Pd, ^{198}Pt, ^{187}Re, ^{103}Rh, ^{181}Ta, and ^{89}Y between 4 and 15 MeV were measured; a comparison was made with production of the same isomer pairs by the (n,γ) reaction. Isomer ratios were also calculated by various approaches and were compared with the experimental results. Film densitometry of internal conversion electron lines was also investigated. An angular anisotropy of the 116- and 306-keV gamma rays from ^{48}Cr was observed, and preliminary measurements of recoil angular distributions from the reactions ^{6}Li(d,n)^{7}Be, ^{197}Au(d,p)^{198}Au, ^{197}Au(d,2n)^{197}Hg, and ^{197}Au(d,t)^{196}Au were made. (D.C.W.)

12025 (NYO–3525-12) STUDIES OF ELECTROMAGNETIC PROPERTIES OF EXCITED STATES OF NUCLEI. Annual Progress Report for 1966. Metzger, F. R. (Bartol Research Foundation, Swarthmore, Pa.). Dec. 12, 1966. Contract AT(30-1)-3525. 19p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Nuclei recoiling after radioactive decays or as a result of nuclear reactions, or nuclei moving at the high velocities available in the Bartol High Speed Rotor Facility, provided the resonant gamma rays for resonance fluorescence experiments with ^{40}Ca, ^{42}Ca, ^{46}Ti, ^{75}As, ^{185}Re, ^{187}Re, ^{191}Ir, and ^{193}Ir. In addition to determining absolute electromagnetic transition strengths and multipole mixing amplitudes, these experiments established previously unknown levels in ^{185}Re, ^{191}Ir, and ^{193}Ir, and led to unambiguous spin assignments for some other levels. Theoretical investigations included the evaluation of the spreading width of analog states which results from the Coulomb interactions in a nucleus. A study of the fine structure of analog states was also made, with particular emphasis on the understanding of the disappearance of the fine-structure strength at a certain point in the spectrum. Particle-hole calculations in nuclei in the mass region A = 90 were carried out. The properties of isospin T = 2 and T = $\frac{3}{2}$ states in the A = 16 region were investigated, and a variational calculation of the deformation of the nucleus C^{12} was performed. (auth)

12026 (ORNL–P–1742) THE POSSIBLE RADIOACTIVE NATURE OF ^{96}Zr. Ball, J. B. (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 6p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The results of binding energy calculations performed as part of a shell-model study of nuclei in the Ar-90 region of the periodic table have led to the prediction that ^{96}Zr is unstable with respect to beta decay into ^{96}Nb. The calculated decay energy is 0.39 MeV. It is suggested that ^{96}Zr may be a long-lived beta emitter and that careful experimental investigation might reveal this radioactivity. (S.F.L.)

12027 (UCRL–50001-66-2) PHYSICS DEPARTMENT REPORT, JUNE–SEPTEMBER 1966. (California Univ., Livermore.

Lawrence Radiation Lab.). Contract W-7405-eng-48. 63p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Theoretical studies were made of N-N scattering, electron scattering by polyatomic molecules, Λ-N interaction, $_{\Lambda\Lambda}He^{6}$, the four-nucleon system, Σ-N interaction, and π-π scattering amplitudes. The fission cross sections of ^{242m}Am and ^{232}U were measured from 0.02 eV to 6 MeV and from 0.004 to 2 keV, respectively. Threshold photoneutron cross sections for Fe and Be were also measured, as were the photoneutron cross sections of ^{89}Y, ^{90}Zr, ^{91}Zr, ^{92}Zr, and ^{94}Zr up to photon energies of 30 MeV. Cross sections for the reaction $^{14}N(n,p_0)^{14}C$ were obtained from measurements of the cross section of the reaction $^{14}C(p,n_0)^{14}N$. The reaction $^{16}C(p,n)^{16}N$ was investigated at proton energies between 7 and 14 MeV; the angular distributions at the highest energies were analyzed using a finite-range DWBA formalism. Angular distributions for the reaction $^{19}F(\alpha,t)^{20}Ne$ were analyzed using a zero-range DWBA formalism. Differential cross sections for (α,n) reactions on ^{17}O and ^{18}O were measured at 9.8, 11.6, and 12.2 MeV; and evidence was also obtained for the $(n,\gamma f)$ reaction on ^{238}Pu for slow neutrons. The neutron scattering cross sections of ^{241}Pu and ^{233}U from 2 to 32 eV and from 2 to 22 eV, respectively, were studied further. Data were also obtained on the de-excitation γ rays following (γ,n) and (γ,p) reactions on ^{16}O; and the spontaneous fission half life of ^{242m}Am was measured, as were the thermal-neutron capture cross sections of Ca, ^{42}Ca, ^{43}Ca, and ^{44}Ca. Neutron diffraction studies of the magnetic transition in NiS as a function of composition were carried out. Bounds on the fugacity and virial series of the pressure in matter were obtained, and the magnetization and conductivity of Fe were studied from 300 to 1250 kbar. Equation-of-state measurements were carried out on rare-earth metals, and elastoplastic wave structure generated in Al by a tangentially accelerated flying plate was studied. A diffusion approximation to the inertial energy transfer in isotropic turbulence was developed; and atmospheric focusing and refraction of blast waves were studied, as was plasma production using multiple laser beams. The effects of various parameters on the output energy from a Q-spoiled ruby oscillator were also studied, and the rate of energy transfer between electrons and ions in a plasma was calculated. (D.C.W.)

12028 (USNRDL-TR-1109) DECAY CHARACTERISTICS OF ^{146}Pm. Bunney, L. R.; Scadden, E. M. (Naval Radiological Defense Lab., San Francisco, Calif.). Nov. 7, 1966. 20p.

The half life of ^{146}Pm was determined to be 2020 ± 18 days. The radionuclide was produced by a (p,n) reaction on enriched ^{146}Nd. The decay of the purified ^{146}Pm was followed on both beta and gamma counters. The gamma energies were determined from pulse-height distribution curves obtained with a Ge(Li) detector. Prominent gamma rays with energies of 453, 736, and 747 keV and low abundance gamma rays with energies of 146, 589, 634, and 1189 kev were observed. (auth)

12029 (ANL-Trans-407) ANGULAR DISTRIBUTION OF ^{232}Th 1.6-MeV NEUTRON FISSION FRAGMENTS. Ermagambetov, S. B.; Smirenkina, L. D.; Smirenkin, G. N.; Tishin, A. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from report FEI-45. 6p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.10 fs, $0.80 mf.

The angular distribution of fragments from the fission of ^{232}Th by 1.6-MeV neutrons was measured by the method of amorphous media (glass). Noticeable deviations from earlier measurements were established. An analysis of the experimental data revealed the inaccuracy of earlier identifications of the predominant fission channels of the ^{233}Th nucleus and established considerable uncertainties in the channel analysis connected with the insufficient knowledge of partial cross sections of the formation of compound nuclei. (auth)

12030 CROSS SECTIONS FOR NUCLEOSYNTHESIS IN STARS AND BOMBS. Bell, George I. (Los Alamos Scientific Lab., N. Mex.). Rev. Mod. Phys., 39: 59-68(Jan. 1967).

Three different processes in which nuclei are synthesized by the multiple capture of neutrons with energies in the keV range are reviewed and compared, namely the s-process and r-process in stars and the synthesis of very heavy nuclei in thermonuclear explosions. In the s-process, neutrons are captured by nuclei in the valley of β-stability. Knowledge of neutron capture cross sections of s-process nuclei can clarify such features of the s-process as elemental abundances, time scales, and temperatures. For producing the heaviest possible nuclei by neutron capture in thermonuclear explosions there are advantages in using the heaviest obtainable target nuclei, but for these there is the disadvantage of serious competition from neutron-induced fission. A channel theory of capture to fission ratios shows encouraging agreement with experiment. More data on capture to fission ratios would be valuable, particularly for odd-odd target nuclei. From capture to fission ratios, the number of open channels for fission can be deduced. (auth)

12031 ELECTRON–PHOTON CASCADE CALCULATIONS AND NEUTRON YIELDS FROM ELECTRONS IN THICK TARGETS. Alsmiller, R. G. Jr.; Moran, H. S. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Nucl. Instrum. Methods, 48: 109-16(Feb. 11, 1967). (ORNL-TM-1502).

The electron-photon cascades induced in cylindrical targets of various sizes and materials by electrons in the energy range of 30 to 200 MeV were studied and calculations of the resulting neutron yields are presented. These calculated yields are compared with experimental yields and approximate agreement is obtained. (auth)

12032 MOESSBAUER EFFECT AND MAGNETIC MOMENT OF THE 75.9 keV LEVEL IN ^{171}Yb. Henning, W.; Kienle, P.; Koerner, H. J. (Technische Hochschule, Munich). Z. Phys., 199: 207-10(1967).

The Mössbauer effect of the second excited state of the $K = 1/2$ rotational band in ^{171}Yb at 75.9 keV with $I = 5/2$ was studied to determine its magnetic moment $\mu = (1.01 \pm 0.01)$ nm. This value agrees well with the one predicted by the previously determined magnetic parameters of the $K = 1/2$ rotational band, confirming the adiabatic separation of intrinsic and rotational wave functions. (auth)

12033 IMPROVED TECHNIQUE FOR MEASURING THE HALF-LIVES OF SHORT-LIVED FISSION GASES. Cordes, O. L.; Cline, J. E.; Reich, C. W. (Phillips Petroleum Co., Idaho Falls, Idaho). Nucl. Instrum. Methods, 48: 125-30(Feb. 11, 1967).

An improved high speed technique for determining the half lives of short-lived radioactive gases was developed. In this technique the half life of the gas is determined from the number of daughter atoms trapped on a series of aerosol filters spaced at equal intervals along a tube through which the gas is flowing. The filters are selected to provide convenient samples for rapid chemical separations and gamma-ray analyses. The general features of the theory, design and construction of the apparatus are discussed as well as the analytical procedures and the factors which govern the accuracy of the half-life measurements. This technique was used to determine a value of 1.18 ± 0.04 sec for the previously unmeasured half-life of ^{142}Xe and a half life of 1.6 ± 0.1 sec for ^{141}Xe. (auth)

12034 GROUND-STATE HYPERFINE STRUCTURE AND NUCLEAR MAGNETIC MOMENT OF ^{169}Tm. Giglberger, D.; Penselin, S. (Univ., Heidelberg). Z. Phys., 199: 244-55(1967).

The hyperfine structure of the $4f^{13}6s^2\ ^2F_{7/2}$ ground state of ^{169}Tm was studied with the atomic beam magnetic resonance method. By measuring strongly field-dependent transitions in external magnetic fields between 2200 and 3000 Gauss the interaction between the nuclear magnetic dipole moment μ_I and the external field was determined. These measurements yielded a direct value for μ_I independent of the electronic properties of the Tm-atom. The results are: $\mu_I = -0.2310\ (15)\ \mu_n$ (diamagnetically corrected), magnetic dipole interaction constant $a = -374.137661(3)$ Mc/sec and $g_J(4f^{13}6s^2\ ^2F_{7/2}) = 1.141189(3)$. (auth)

12035 OBSERVATION OF GOLD ISOTOPES WITH ANOMALOUS CROSS SECTIONS BY BOMBARDMENT OF ^{238}U WITH ^{22}Ne IONS. Wang, Tung-sheng; Yeh, Wei-wen; Ma, Chun-tsan, Wu Li Hsueh Pao, 22: 708-13(June 1966). (In Chinese).

Separation of gold isotopes from the $^{238}U(^{22}Ne,f)$ reaction was achieved using radiochemical methods. The gold isotopes were identified by measuring x-ray spectra. The ^{199}Au cross section of 5×10^{-27} cm^3 was higher by about three orders of magnitude than the cross sections previously extrapolated according to the well-known curve for $^{238}U(^{22}Ne,f)$. The formation of ^{199}Au with a cross section near 1 mb in the $^{238}U(^{22}Ne,f)$ reaction, which can not be explained by the transfer of nuclei, was analyzed. (tr-auth)

12036 MEASUREMENT OF K X-RAY EMISSION IN THE DECAY OF ^{103m}Rh. Bresesti, A. M.; Bresesti, M.; Neumann, H. (CCR-EURATOM, Ispra, Italy). J. Inorg. Nucl. Chem., 29: 15-20 (Jan. 1967).

The number of K x-rays emitted per disintegration of ^{103m}Rh was measured by evaluating the x_K emission with a 6 mm thick NaI(Tl) crystal, and by evaluating the absolute ^{103m}Rh activity by means of a $4\pi\beta$-γ measurement of ^{103}Ru samples in which the ^{103m}Rh was in equilibrium. A value of $x_K/dis = 0.0700 \pm 0.0035$ was obtained for the conversion of the 40-keV level of ^{103m}Rh, corresponding to a value of $K/(L + M + N) = 0.0986 \pm 0.0050$. The errors quoted include estimated systematic errors as well as the internal uncertainty of measurement. The fluorescent yield of the K shell was assumed to be 0.780. (auth)

12037 FISSION OF ^{233}U BY THERMAL NEUTRONS. Ganapathy, R.; Mo, T.; Meason, J. L. (Univ. of Arkansas, Fayetteville). J. Inorg. Nucl. Chem., 29: 257-61(Jan. 1967).

The fission yields of five consecutive mass chains in the region A = 131 to 135 were measured by isolating the iodine isotopes, using radiochemical techniques, and comparing the results with the mass-spectrometric data. (auth)

12038 FISSION OF ^{223}Ra BY REACTOR NEUTRONS. Jain, H. C.; Ramaniah, M. V.; Rao, C. L.; Prakash, S. (Atomic Energy Research Establishment, Trombay, India). J. Inorg. Nucl. Chem., 29: 267-9(Jan. 1967).

Fission of ^{226}Ra by charged particles and by neutrons of different energies has been studied; the studies suggest a transition from predominantly asymmetric to symmetric fission as the fissioning nucleus changes from thorium to radium. In view of this suggested trend, a study of mass distribution in the fission of actinides was undertaken; in this connection it was considered desirable to study the fission behavior of a lighter isotope of radium with reactor neutrons. ^{223}Ra was chosen due to its availability as a daughter product of ^{227}Ac. (auth)

12039 MAGNETIC MOMENT OF THE FIRST EXCITED STATE OF ^{114}Cd. Bhattacherjee, S. K.; Bowman, J. D.; Kaufmann, E. N. (California Inst. of Tech., Pasadena). Phys. Rev. Lett., 18: 223-5(Feb. 6, 1967).

The magnetic moment of the first 2^+ state at 558.5 keV in ^{114}Cd was measured to be $|\mu_2| = 0.88 \pm 0.12\ \mu_N$ by the perturbed gamma-gamma angular correlation technique utilizing the internal hyperfine field in an Fe lattice. (auth)

12040 ISOTOPE SHIFTS IN MEDIUM-HEAVY ELEMENTS. King, W. H.; Kuhn, H. G.; Stacey, D. N. (Oxford Univ.). Proc. Roy. Soc. (London), Ser. A, 296: 24-37(Jan. 10, 1967).

Isotope shifts in the atomic spectra of elements covering the range between the magic neutron numbers 50 and 82 are discussed in terms of nuclear charge distribution. A comparison with evidence obtained from Coulomb excitation experiments shows that for some elements the variation of field shifts within the sequences of even-even isotopes can not be due solely to deformation effects, whether static or vibrational. A quantitative treatment shows that the increase of nuclear volume, or the change of nuclear charge distribution due to purely radial, as distinct from deformation, effects, occurs in markedly unequal steps as neutron pairs are added. The evidence is particularly striking in Sn and Cd, where deformations are small and vary little among the even isotopes. Values of radial changes are obtained from the isotope shift results and are compared with the values predicted from electron scattering data. It also appears that the odd-even staggering can not always be attributed to deformation effects. (auth)

12041 FERMI MATRIX ELEMENTS IN THE BETA DECAY OF ^{234}Np. Hansen, P. G. (Research Establishment, Riso, Denmark); Nielsen, H. L.; Wilsky, K.; Cuninghame, J. G. Phys. Lett., 24B: 95-7(Jan. 23, 1967).

There is strong evidence that the ground-state spin and parity of the odd-odd nucleus ^{234}Np is 0^+. Consequently, a β^+ branch, log ft = 8.25 ± 0.06, to the ^{234}U ground state represents an isospin-forbidden pure Fermi transition. Two excited 0^+ states observed at 809.8 and 1043.5 keV are also fed directly in the beta decay with log ft values of 9.2 in both cases. (auth)

12042 THE STRONGEST TRANSITIONS FROM THE (t,p) REACTIONS ON Cd AND Sb. Hinds, S.; Marchant, H.; Middleton, R. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Phys. Lett., 24B: 89-91(Jan. 23, 1967).

The Q values and angular distributions were measured for the (t,p) reactions leading to the ground states of most of the Cd isotopes and of ^{125}Sb, and also to the first excited state of ^{123}Sb. All are strong L = 0 transitions. (auth)

12043 EMISSION OF LONG-RANGE CHARGED PARTICLES IN THE FISSION OF ^{235}U INDUCED BY THERMAL NEUTRONS. Chwaszczewska, J.; Dakowski, M.; Krogulski, T.; Piasecki, E.; Przyborski, W.; Sowinski, M. (Inst. of Nuclear Research, Warsaw). Phys. Lett., 24B: 87-9(Jan. 23, 1967).

The relative intensities of light particles (p,d,t, and ^{6}He) associated with thermal-neutron fission of ^{233}U were measured. Also events were observed which were attributed to heavier fragments like ^{8}He, Li, and Be. (auth)

12044 INTERNAL BREMSSTRAHLUNG FROM ^{204}Tl AND ^{91}Y. Narasimhamurty, K.; Jnanananda, S. (Andhra Univ., Waltair, India). Proc. Phys. Soc. (London), 90: 109-23(Jan. 1967).

The continuous spectra of internal bremsstrahlung from the beta decays of ^{204}Tl and ^{91}Y were measured by using a single-channel NaI(Tl) scintillation spectrometer, together with a standard geometrical arrangement. Care was taken to avoid spurious effects; and corrections were made for several factors, such as background, energy resolution, back-scattering, Compton and escape electrons, geometrical and gamma detection efficiency of the crystal, and absorption of the radiation between source and detector. The total yields of intensity and of energy of internal bremsstrahlung from each of the isotopes ^{204}Tl and ^{91}Y in the investigated energy regions were also determined and compared with the corresponding theoretical values. For both the isotopes the experimental results are compared with the allowed theory of Knipp and Uhlenbeck and of Bloch (KUB theory) and also with the Coulomb-corrected theories of Lewis and Ford and of Nilsson. In the energy region from 90 to 550 keV for ^{204}Tl there is reasonable agreement between experiment and the Coulomb-corrected theory of Nilsson above 300 keV, while below 300 keV the experimental results are much higher than the theoretical results. For ^{91}Y there is no harmony at all between experiment and theory throughout the energy region from 100 to 1000 keV, the experimental results considerably exceeding those predicted from theory. Moreover, the divergence between experiment and theory is found to increase with increasing energy. (auth)

12045 PRESENCE OF HIGHER LEVELS OF ^{144}Nd IN THE DECAY OF ^{144}Pm. Eissa, Nabil A.; Berenyi, Denes; Mathe, Gyoergy. ATOMKI (At. Kut. Intez.) Kozlem., 8: 204-8(Sept. 1966). (In Russian).

It was found by scintillation spectroscopic measurements that levels (2.1 and 2.2 MeV) higher than 1.78 MeV of ^{144}Nd are present in the decay of ^{144}Pm. For the total disintegration energy of the ^{144}Pm–^{144}Nd decay the following limits were obtained: $2230 < E_d < 2650$ keV or probably $2400 < E_d < 2650$ keV. (auth)

12046 METHOD FOR LEAST-SQUARES ANALYSIS OF GAMMA-RAY SCINTILLATION SPECTRA USING A BENT-CRYSTAL MONOCHROMATOR. Brown, J. E.; Hatch, E. N. (Ames Lab., Iowa). Contract W-7405-eng-42. Nucl. Instrum. Methods, 47: 185-93(1967). (IS–1082).

A method is presented for determining gamma-ray relative intensities using features of the conventional least-squares analysis of a NaI pulse-height spectrum combined with the crystal-diffraction method. In studying the gamma rays from a radioactive source, a bent-crystal spectrometer is used as a gamma-ray monochromator to obtain monoenergetic gamma rays using a strong line source. The individual response functions of a NaI detector to these monoenergetic gamma rays are recorded in a multichannel analyzer. The NaI detector is then directly exposed to a second thin line source of the same source material, placed on the focal circle of the monochromator, and the composite pulse-height spectrum in the NaI detector of all gamma rays from the source is recorded. The relative intensities of the gamma ray are then determined by a least-squares adjustment of the appropriate linear combination of monochromatic response functions to obtain the best fit to the composite pulse-height spectrum. The relative intensities of gamma rays from ^{169}Tm following electron capture of ^{169}Yb obtained with this method show good agreement with those obtained using the crystal-diffraction method. (auth)

12047 THE DETERMINATION OF THE FAST-FISSION CROSS SECTION OF ^{233}Pa WITH FISSION NEUTRONS. von Gunten, H. R.; Buchanan, R. F.; Wyttenbach, A.; Behringer, K. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). Nucl. Sci. Eng., 27: 85-94(Jan. 1967).

The fast-fission cross section of ^{233}Pa was determined for a fission-neutron spectrum originating from a ^{233}U source that was exposed to thermal reactor neutrons. The σ_f was measured by comparing the fission rate of a known quantity of ^{233}Pa to that of a known thorium sample, using back-to-back fission counters. An average above-threshold value of 775 ± 190 mb was found, based on a fission cross section of 142 mb for ^{232}Th and an assumed threshold of 0.9 MeV for ^{233}Pa. This value is in very good agreement with published estimated values. The characteristics of the fission counter in the presence of the high beta background resulting from 0.3 to 1.8 Ci of ^{233}Pa were investigated. (auth)

12048 APPLICATION OF HARLEY–HALDEN METHOD IN THE ANALYSIS OF INTEGRAL β SPECTRA. Gedeonov, L. I.; Yakovleva, G. V.; Eliseeva, I. M. At. Energ. (USSR), 21: 308-11 (Oct. 1966). (In Russian).

A beta scintillation spectrometer (with 30 mm × 15 mm stilbene crystal, cathode repeater, discrimination amplifier, and computing scheme) was used for identifying radioisotopes and indicating their radiochemical purity. The integral β spectra for ^{137}Cs, ^{144}Pr, ^{106}Rh, ^{90}Sr, and ^{204}Tl (fine sources) were analyzed by Harley–Halden method and their curves were constructed using ^{91}Y as the reference line. The energy dependence of the tangent formed by a rectilinear graph of the integral spectral with ordinate axis is shown. The empirical function is used for determining β spectrum boundary energy with the order of ~10%. The identification time at 10^{-8} C activity is about 10 min and varies in inverse proportion

to the activity of the material. The method was used also for ^{89}Sr, ^{144}Ce, and $^{90}Sr + ^{90}Y$ (100 mg/cm^2 thick and 5 mm in diameter plates pressed to a lead lining) and two component mixtures $^{141}Ce + ^{144}Ce$. The analysis of two component radioactive mixtures with 10^{-9} C activity took 2 hr. (R.V.J.)

12049 SOME NOTES ON ALPHA EMITTERS PRODUCED IN Au BY HIGH-ENERGY PROTONS. Charalambus, St. (CERN, Geneva). Nucl. Phys., A94: 26-32(Mar. 1967).

The induced alpha radioactivity in gold produced by protons with energies greater than 600 MeV was studied. It was found that besides a 4.1-hr half life attributed to ^{149}Tb, other alpha radionuclides with half lives about 7 and 19 min are produced in important quantities. The radionuclides with the 7-min half life are probably ^{150}Dy and ^{153}Ho; with the 19-min half life, it is ^{151}Dy. The 7-min and 19-min radionuclides were measured, and yields in relation to ^{149}Tb were found to be 2.62 and 1.22, respectively. These yields were compared with the calculated values using Rudstam's formula. A list of other alpha radionuclides below gold is also given, and a probability for their production and measurement is calculated. (auth)

12050 COUPLED-CHANNEL, ALPHA DECAY RATE THEORY APPLIED TO ^{212m}Po. Rauscher, E. A.; Rasmussen, J. O. (Univ. of California, Berkeley). Nucl. Phys., A94: 33-51(Mar. 1967).

A new application of the coupled-channel formalism is made for the case of the alpha decay of the high spin, $J = 18^+$ state of ^{212}Po to the ground state and various excited states of ^{208}Pb. The microscopic or "shell-model" rate theory is applied first, neglecting coupling. It is found that the theory underestimates both the experimental 1% alpha branch to the 3^- first excited state of ^{208}Pb and the 2% branch to the second 5^- state, for connection radius R = 9.5 fm. Choice of a small R of 7.5 fm results in a satisfactory agreement for the branching to the 5^- state, but leaves a discrepancy of over an order of magnitude for the branch to the 3^- state. The radial Schrödinger equations are solved for L = 18 and L = 15 waves coupled to the collective octupole vibrational field. It is shown that the channel coupling has a substantial effect on over-all barrier penetrability, but that coupling does not help much in removing the underestimate of the 3^- intensity for $R \geq 7.5$ fm for the parameters used. It is suggested that neglected octupole core polarization in parent nuclear wave functions may be responsible for the remaining discrepancy. (auth)

12051 LEVELS IN ^{196}Pt FROM THE DECAY OF 6.2-DAY ^{196}Au. Jansen, J. F. W.; Pauw, H. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Nucl. Phys., A94: 235-40(Mar. 1967).

The gamma spectrum of 6.2-day ^{196}Au was measured with germanium detectors. Previously unresolved and unreported gamma rays at 393.4 ± 0.4, 659.5 ± 0.3, 673.5 ± 0.7, 1005.7 ± 0.3, 1361.0 ± 1.0, and 1446.3 ± 0.7-keV were found. As a consequence, the level scheme of ^{196}Pt was slightly revised. The cascade of about equally strong gamma rays following decay of 1.4-hr ^{196}Ir has energies of 356.0 ± 0.5, 393.7 ± 0.5, 447.6 ± 0.5, 521.4 ± 0.5, and 647.9 ± 0.6 keV. (auth)

12052 A DETERMINATION OF QUADRUPOLE MOMENTS IN ^{114}Cd, ^{130}Ba, ^{148}Sm, AND ^{150}Sm. Simpson, J. J. (Univ. of Oxford); Eccleshall, D.; Yates, M. J. L.; Freeman, N. J. Nucl. Phys., A94: 177-91(Mar. 1967).

By Coulomb exciting ^{114}Cd, ^{130}Ba, ^{148}Sm and ^{150}Sm with sulphur and oxygen ions, it was possible to observe the re-orientation effect. The interpretation of this effect by using a numerical multiple Coulomb excitation code as well as by a perturbation treatment of Coulomb excitation permitted the quadrupole moment of the first 2^+ state of the nuclei to be determined. The B(E2; $0^+ \rightarrow 2^+$) values were also determined. (auth)

12053 END POINT OF THE RaE BETA SPECTRUM. Hsue, S. T.; Kim, M. U.; Tang, S. M. (Indiana Univ., Bloomington). Contract Nonr 1705(02). Nucl. Phys., A94: 146-50(Mar. 1967).

By demanding an energy signature with a semiconductor detector in addition to the momentum selection of a magnetic spectrometer, the end point of the RaE beta spectrum was determined without requiring any ambiguous corrections for scattering and background. The value of the end point was found to be 1.1615 ± 0.0015 MeV. (auth)

12054 THE HALF-LIFE AND DECAY OF ^{189}Au. Naumann, R. A.; Petry, R. F.; Evans, J. S. (Princeton Univ., N. J.). Nucl. Phys., A94: 151-6(Mar. 1967).

The half life of ^{189}Au was positively identified as 29.7 min by a combination of chemical and mass fractionation techniques. The principal transitions accompanying the decay of ^{189}Au were incorporated into a rudimentary level scheme for ^{189}Pt. (auth)

12055 BETA-GAMMA DIRECTIONAL CORRELATION IN THE DECAY OF ^{148}Pm. Nainan, T. D.; Moore, S. E. (Nebraska Wesleyan Univ., Lincoln). Nucl. Phys., A94: 257-60(1967).

Directional correlation measurements between the β group of maximum energy 1.90 MeV and the succeeding γ ray of 0.551 MeV were made at six different energies. It is concluded that the deviation from the ξ approximation is small, if any. (auth)

12056 MEASUREMENT AND ANALYSIS OF MUONIC X-RAY SPECTRA IN DEFORMED NUCLEI. De Wit, S. A. (CERN, Geneva); Backenstoss, G.; Daum, C.; Sens, J. C.; Acker, H. L. Nucl. Phys., 87: 657-702(1967).

Muonic x-ray spectra were investigated for a number of elements and separate isotopes between Z = 62 and Z = 94, where strong deviations from a spherical shape for the nuclear charge distribution due to collective effects occur. The x-ray transition energies were measured with a Ge Li-drifted detector. For the monoisotopic nuclei Ta, Th, ^{235}U, ^{238}U, and ^{239}Pu, $2p \rightarrow 1s$ and $3d \rightarrow 2p$ transitions were analyzed; for the monoisotopic nuclei Tb, Ho, and ^{233}U and the multi-isotopic elements Sm, Eu, Hf, W, Os, and Ir only the $2p \rightarrow 1s$ transitions were used in the analysis. The data were analyzed in terms of a charge distribution of the Fermi type, which was modified to take into account the deformations of the nuclei in question. This modification is not unique but depends on a nuclear model. Two models were considered; in the first, the entire nucleus is deformed, in the second the deformation resides only in the surface layer. Comparison between the calculated and measured spectra leads to a determination of the radial parameter c and the surface thickness parameter t and to a determination of the intrinsic nuclear quadrupole moment Q_0, which is in good agreement with data from other methods. From the ensemble of data on Ta, Th, and ^{238}U, it is concluded that the second, or hard-core model, fits the observations less well. The systematic features of the x-ray data show possibly that for deformed nuclei the radial parameter c is slightly larger, the central nuclear charge density lower than is the case for nearly spherical nuclei. For most nuclei, $4f \rightarrow 3d$ and $5g \rightarrow 4f$ transitions were also observed. (auth)

12057 DECAY OF ^{102}Ag AND LEVELS IN ^{102}Pd. Charoenkwan, Prasit; Richardson, J. Reginald (Univ. of California, Los Angeles). Nucl. Phys., A94: 417-26(1967).

The decay of the ^{102}Ag isomers was investigated using magnetic-lens, scintillation, and solid-state spectrometers. Half lives of 13 ± 0.4 and 7.7 ± 0.5 min were assigned to the 5^+ and 2^+ spin isomers, respectively. Beta rays of 4.06, 3.37, 3.07, 2.26, 1.90, 1.50, 1.00 and 0.65 MeV end-points and gamma rays of 0.558, 0.727, 0.86, 1.01, 1.28, 1.60, 1.70, 1.80, 2.07, 2.79, 3.23 and 3.33 MeV were observed, and a large amount of K-capture was found. The isomeric transition proceeds by means of the internal conversion process. A partial decay scheme was proposed on the basis of the γ-γ, γ-γ-γ, β-γ, and X-ray-γ coincidences. (auth)

12058 NEW TRANSITIONS AND PRECISE ENERGY AND INTENSITY DETERMINATIONS IN THE DECAY OF ^{177m}Lu. Haverfield, A. J.; Bernthal, F. M.; Hollander, J. M. (Univ. of California, Berkeley). Nucl. Phys., A94: 337-50(1967). (UCRL-16862).

The decays of ^{177}Lu (6.8 day) and ^{177m}Lu (155 day) to excited states in ^{177}Hf and ^{177}Lu were studied with a high-resolution, lithium-drifted germanium detector. Three previously unreported gamma rays were placed in the decay scheme. Improved relative intensity measurements have allowed recalculation of E2/M1 mixing ratios and E1 branching ratios. A precise determination of the transition energies in ^{177m}Lu decay was made. The E1 transition probabilities in ^{177}Hf are compared with simple theory. (auth)

12059 GAMMA-RAY SPECTRUM FROM $^{204}Pb(n,\gamma)^{205}Pb$. Jurney, E. T. (Los Alamos Scientific Lab., N. Mex.); Motz, H. T.; Vegors, S. H. Jr. Nucl. Phys., A94: 351-65(1967). (LA-DC-8289).

The gamma spectrum following thermal neutron capture by ^{204}Pb was observed to populate directly 16 levels in ^{205}Pb. A total of 23 low-energy gamma rays, of which three are doubtful, were observed to depopulate these levels. A decay scheme using the above information is proposed and is compared to theoretical predictions. The neutron binding energy for ^{205}Pb was determined to be 6734.2 ± 1.5 keV, and the neutron capture cross section for ^{204}Pb was found to be 661 ± 70 mb. (auth)

12060 DECAY OF ^{132}La. Frana, J. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez); Rezanka, I.; Plajner, Z.; Spalek, A.; Jursik, J.; Vobecky, M.; Mastalka, A.; Funke, L.; Graber, H.; Sodan, H. Nucl. Phys., A94: 366-84 (1967).

The decay of ^{132}La was investigated by means of beta spectrometers, Ge(Li) detectors, and coincidence techniques employing scintillation and Ge(Li) detectors. The existence of levels in ^{132}Ba at 464.2 (2^+), 1031.1 (2^+) and 1127.0 keV (4^+) was confirmed. Previously unreported levels at 1667 (4^+), 1685, 1728, 2067 (3^-, 2^-), 2373 (3^-, 2^-), 2566 (3^-), 3155, 3217, 3423, 3492, 3562, 3633, and 3662 keV were established from energy, intensity, and (partly) co-

incidence information. The ^{132}La ground-state spin and parity were determined to be 2^-. The data are discussed in terms of the vibrational model. (auth)

12061 NUCLEAR SPECTROSCOPY WITH ^{204}Pb. Bjerregaard, J. H. (Univ. of Copenhagen); Hansen, Ole; Nathan, O.; Hinds, S. Nucl. Phys., A94: 457-75(1967).

The reactions ^{204}Pb(d,t), ^{204}Pb(d,d') and ^{204}Pb(t,p) were investigated at incident energies of 12–13 MeV, the reaction products being momentum analysed in a multi-angle, magnetic spectrograph. Seven excited states were observed in ^{203}Pb up to 2.8-MeV excitation energy; 27 excited states were observed in ^{205}Pb up to 4.1-MeV excitation energy; five excited states were identified in ^{204}Pb up to 2.7-MeV excitation energy, and four excited states were found in ^{206}Pb up to 3.8-MeV excitation energy. The measured angular distributions from the single transfer reactions (d,p) and (d,t) were compared with DWBA predictions, and spectroscopic factors were deduced for a number of levels. For the states of ^{203}Pb and ^{205}Pb near the Fermi surface and for the ^{204}Pb ground state the results are in general agreement with the pairing model. The data suggest that the four hole-two particle strength of ^{206}Pb is distributed over many close levels. (auth)

12062 HALF-LIVES OF SOME SHORT-LIVED RADIOACTIVE ISOTOPES. Yule, Herbert P. (Texas A and M Univ., College Station). Nucl. Phys., A94: 442-8(1967).

Half lives of several short-lived radioactive species were measured by irradiation with reactor neutrons or 14-MeV neutrons, counting their gamma radiations with an NaI(Tl) detector and a multi-scaler, and computer analysis of the data. Contributions or extraneous isotopes were carefully examined to eliminate errors arising from this source, and other sources of error were considered. Measured half lives in sec are 26.76(^{19}O), 10.31(^{20}F), 38.68(^{23}Ne), 18.67(^{46m}Sc), 17.38(^{77m}Se), 4.88(^{79m}Br), 60.99(^{86m}Rb), 16.06(^{89m}Y), 24.93(^{110}gAg), 56.44(^{139m}Ce), 18.60(^{179m}Hf), 7.67(^{197m}Au), and 0.743(^{207m}Pb). The results for ^{23}Ne, ^{77m}Se, ^{79m}Br, ^{86m}Rb, ^{89m}Y, and ^{197m}Au are in good agreement with published values, while serious discrepancies exist for ^{19}O, ^{20}F, and ^{110g}Ag. Discrepancies between measured and literature values for ^{46m}Sc and ^{207m}Pb are probably not serious in view of the age of the literature results. The result for ^{139m}Ce is in agreement with one literature value, but in disagreement with another. (auth)

12063 INELASTIC SCATTERING SPECTRA OF 14.1-MeV NEUTRONS AND NUCLEAR LEVEL DENSITIES. Salnikov, O. A.; Fetisov, N. I.; Lovchikova, G. N.; Kotelnikova, G. V.; Anufrienko, V. B.; Devkin, B. V. Yadern. Fiz., 4: 1154-61(Dec. 1966). (In Russian).

The spectra of secondary neutrons, produced in the interactions of 14.1-MeV neutrons with Be, Na, Mg, S, K, Ca, Sr, In, Sb, I, Cs, Ce, Ta, and Hg nuclei were investigated. The measurements were performed by the time-of-flight method with a ring geometry. The temperatures were determined, characterizing the excitation of the nucleus after the emission of the first neutron; and the values of the nuclear level density parameter were calculated on the basis of the Fermi gas model, taking the residual interaction into account in the form of pairing energy. The values of the nuclear level density parameter were compared with the results of other papers, in which the parameter was determined by other methods. It was found that the Fermi gas model, with the residual interaction taken into account, gives a correct description of the dependence of the temperature and nuclear level density parameter on the mass number A and the excitation energy, except for nuclei in the magic region in which shell effects show up. (auth)

12064 THE EXPERIMENTAL ASPECT OF THE INTERACTIONS OF 25-GeV/c PROTONS WITH Br AND Ag NUCLEI IN NUCLEAR EMULSION. II. INVESTIGATION OF CORRELATIONS BETWEEN THE EMISSION OF HEAVY FRAGMENTS AND THE CHARACTERISTICS OF THE INTERACTION FROM WHICH THEY ARISE. Stein, R. (Centre de Recherches Nucleaires, Strasbourg). J. Phys. (Paris), 27: 513-16(Sept.-Oct. 1966). (In French).

Possible correlations between the emitted fragment and the characteristics of the parent stars were investigated. (auth)

12065 HALF LIVES OF EXCITED LEVELS OF ^{40}Ca AND ^{132}I. Gorodetzky, S.; Schulz, N.; Chevallier, J.; Knipper, A. C. (Institut de Recherches Nucleaires, Strasbourg). J. Phys. (Paris), 27: 521-5(Sept.-Oct. 1966). (In French).

The half life $T_{\frac{1}{2}} = 2.15 \pm 0.08$ nsec was measured for the first excited state in ^{40}Ca. Delayed coincidence measurements in ^{132}I determine the emission order of the 52 and 232 keV γ rays; half lives were measured to be $T_{\frac{1}{2}} = 0.96 \pm 0.04$ nsec for the 52-keV level and $T_{\frac{1}{2}} = 1.42 \pm 0.05$ nsec for the 284-keV level. These values, together with measured internal conversion coefficients α_K, allow assignment of multipole orders M1 + E2 and E2, respectively, for the 52- and 232-keV transitions. (auth)

12066 ON FISSION WITH α-PARTICLE EMISSION. Pik-Pichak, G. A. Yadern. Fiz., 4: 1147-53(Dec. 1966). (In Russian).

Calculations of the angular correlations of neutrons and α particles emitted in the thermal-neutron triple fission of the ^{235}U nucleus are carried out. The anisotropy of the neutron angular distribution with respect to the direction of the emission of the α particle enables one to make some remarks concerning α-particle formation in triple fission. (auth)

12067 ON THE DECAY OF ^{159}Ho. Gromov, K. Ya.; Mukhtasimov, F. N. Yadern. Fiz., 4: 1102-7(Dec. 1966). (In Russian).

Using a β spectrograph with a steady uniform magnetic field, the spectra of conversion electrons from the decay of ^{159}Ho were studied. The resolving power of the β spectrograph was about 0.05%. Previously unreported γ transitions with the energies: 31.40, 41.14, 85.70, 100.60, 105.30, 132.00, 136.50, 153.05, 185.85, 186.40, 205.90, 217.67, 258.80, 338.70, 356.40, and 395.40 keV were found. The multipolarities of a number of γ transitions in ^{159}Ho were determined. A decay scheme of ^{159}Ho is proposed on the basis of the data obtained. (auth)

12068 THE α DECAY OF FIVE CURIUM ISOTOPES WITH THE MASS NUMBERS 242 TO 246. Baranov, S. A.; Rodionov, Yu. F.; Kulakov, V. M.; Shatinskii, V. M. Yadern. Fiz., 4: 1108-21(Dec. 1966). (In Russian).

The α decay of the isotopes ^{242}Cm, ^{243}Cm, ^{244}Cm, ^{245}Cm, and ^{246}Cm was studied using an α spectrograph, semiconductor spectrometer, proportional γ counter, Ge–Li γ detector and α-γ coincidence technique. The α, γ, and α-γ spectra from samples of different isotope mixtures are given and are discussed. On basis of the experimental data the energy-level diagrams of the daughter nuclei ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, and ^{242}Pu with previously unreported excited states produced in the α decay are constructed. (auth)

12069 THE LIFETIMES OF THE FIRST EXCITED ENERGY LEVELS OF ^{139}La AND ^{147}Pm. Begzhanov, R. B.; Gladyshev, D. A.; Sadykov, K. M.; Teshabaev, K. T. (Inst. of Nuclear Physics, Academy of Sciences, Uzbek SSR). Yadern. Fiz., 4: 1097-1101(Dec. 1966). (In Russian).

The lifetimes of the first excited energy levels of ^{139}La and ^{147}Pm were measured by the delayed coincidence technique. The half lives of the levels of the nuclei ^{139}La (166 keV) and ^{147}Pm (91 keV) were found to be $1.48 \pm 0.03 \times 10^{-9}$ sec and $2.34 \pm 0.04 \times 10^{-9}$ sec, respectively. A comparison of these results with the theoretical predictions by Arima and by Spruch is given. (auth)

12070 COMPARISON OF THE NEUTRON EMISSION CHARACTERISTICS IN THE FISSION OF ^{233}U AND ^{235}U. Blinov, M. V.; Kazarinov, N. M.; Protopopov, A. N. Yadern. Fiz., 4: 1179-82(Dec. 1966). (In Russian).

The energy and angular distributions of neutrons from the thermal-neutron fission of ^{233}U and ^{235}U were measured by the time-of-flight method. The measurements were performed under identical conditions, so as to compare the data for the two uranium isotopes in detail. The distributions were found to differ insignificantly. The experimental values differ from the calculated values at the angle 90° for both isotopes. (auth)

12071 STUDY OF NEUTRON PICK-UP IN THE BOMBARDMENT OF ^{181}Ta, ^{197}Au, ^{232}Th, AND ^{238}U ISOTOPES BY ^{15}N IONS. Artyukh, A. G.; Volkov, V. V.; Kwiecinska, T. Yadern. Fiz., 4: 1165-78(Dec. 1966). (In Russian).

The neutron pick-up was investigated in the bombardment of ^{181}Ta, ^{197}Au, ^{232}Th, and ^{238}U by ^{15}N ions with energies up to 102 MeV. Radioactive ^{16}N was detected as the reaction product. Data were obtained on the angular distribution, effective cross section, and ^{16}N energy spectrum. The angular distribution measured at 102 and 93 MeV has characteristic peaks, corresponding to tangential collisions of ^{15}N and the target nucleus. No significant peak was found for the zero angle. The effective cross section increases rapidly near the Coulomb barrier, tending to saturation as the energy increases. For ^{232}Th and ^{238}U, the reaction cross section is approximately equal to 13 mb and to 4 mb for ^{181}Ta and ^{197}Au at ^{15}N energies about 20 MeV above the Coulomb barrier. It follows from the data on the energy spectrum that the neutron transfer does not result in an appreciable excitation of the target nucleus. A comparison of the angular distributions and ^{181}Ta and ^{197}Au excitation functions shows that the nuclear deformation does not markedly influence the neutron transfer. (auth)

12072 INVESTIGATION OF ^{103}Rh(n,^{3}He)^{101}Tc REACTION. Csikai, J. (Inst. of Nuclear Research, Hungarian Academy of Sciences, Debrecen). Acta Phys. Acad. Sci. Hung., 21: 229-33 (1966).

The cross section of the ^{103}Rh(n,^{3}He)^{101}Tc reaction was determined at 14.7 MeV neutron energy by the activation method. The

value $\sigma(n,^3He) = 1.2$ μb was observed. The cross-section ratio of the $(n,^3He)$ and (n,α) reactions for nucleus ^{103}Rh was calculated on the basis of the statistical model. The comparison of the values of the measured ratio and that calculated shows that the relatively high yield of the $(n,^3He)$ reaction can not be explained on the basis of the statistical model. (auth)

12073 ABSOLUTE DETERMINATION OF FISSION RATES IN ^{235}U AND ^{238}U AND CAPTURE RATES IN ^{238}U BY RADIOCHEMICAL TECHNIQUES. Armani, R. J. (Argonne National Lab., Ill.). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/54, 6p. (CONF-661012-8). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

Radiochemical techniques were developed and used for the measurement of ^{235}U and ^{238}U fission rates and ^{238}U capture rates. Recent improvements in these methods have resulted in an increase in precision and more confidence in the absolute accuracy of the measurements. Fission rates are measured by extracting the ^{99}Mo fission product from an irradiated U foil. The total ^{99}Mo activity is found by absolute β counting and the determination of chemical yield. The precision of the measurement has been increased by the reduction of experimental errors in the extraction process. The absolute calibration of the end window β counter was improved by employing a ^{99}Mo solution. The activity of this solution was determined by both $4\pi\beta$ counting and $4\pi\beta$-γ coincidence counting. Capture rates are measured by allowing ^{239}U, formed in an irradiated ^{238}U foil, to decay to ^{239}Np. The ^{239}Np is then extracted by an ion exchange process. The chemical yield is determined by α counting a ^{237}Np tracer. The ^{239}Np activity is determined by absolute β counting. The precision has been improved by introducing an electroplating technique to produce uniform Np samples. The absolute calibration of the end window counter was improved by employing a ^{239}Np solution. The activity of this solution was determined by $4\pi\beta$ counting. These improvements have resulted in precisions of 1% in both fission and capture rate measurements and accuracies of about 2% for each case. Experimental data obtained with the improved techniques will be presented. (auth)

Nuclear Theory

Refer also to abstracts 11970, 11987, 12024, and 12050.

12074 (CEA-R-3025) CORRELATIONS DIRECTIONNELLES ELECTRON-GAMMA. (Electron–Gamma Directional Correlations). Gerholm, Tor Ragnar (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct. 1966. 50p. (In French). Dep. mn.

The theory of the angular correlation between conversion electrons and gamma rays is briefly outlined. The experimental methods used for the study of the electron-gamma correlation are described. The effects of the formation of a hole and the hyperfine structure magnetic coupling dependent on time are then considered. The experimental results showed that the attenuations found for different metallic media plainly conform to a simple quadripolar interaction mechanism. For a source surrounded by an insulator, however, the results show that a rapidly disappearing coupling occurs as a supplement to the quadripolar interaction mechanism. This coupling attenuates the angular correlation by about 75% of the non-perturbed value. It was concluded that for an intermediate half life of the level of the order of the nanosecond, the attenuations produced by the secondary effects of the hole formation can not be completely neglected. The metallic media considered were Ag, Au, Al, and Ga. In the study of E2 conversion processes, the radical matrix elements governing the E2 conversion process in the 412-kev transition of ^{198}Hg were determined. The results exclude the presence of dynamic contributions within the limits of experimental error. The values b_2 (E2) and α_k (E2) obtained indirectly from the experimentally determined b_4 particle parameter are in complete agreement with the theoretical values obtained by applying the corrections due to the shielding effect and to the finite dimension of the nucleus and excluding the dynamic contributions. The value for the internal conversion coefficient was also in good agreement. Experimental results from the intensity ratios between the peak and the continuum, however, seem to show significant deviations with respect to other experimental and theoretical values. There is good agreement between experimental and theoretical results on the internal conversion of ^{203}Tl, ^{201}Tl, and ^{181}Ta. The theory of internal conversion process containing the dynamic effects appears to be coherent and well understood. The penetration matrix effects can then be used as independent and complementary sources of information for the study of problems on nuclear structure. (J.S.R.)

12075 (JINR-E4-3034) RESIDUAL INTERACTION IN NUCLEI. Bochnacki, Z.; Holban, I. N.; Mikhailov, I. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 26p. Dep. mn.

The residual interaction in nuclei is introduced through the self-consistency conditions for the single-particle potential of the generalized Hartree-Fock method. The general features of the interaction are discussed, and its explicit form is derived for some realistic models giving the single-particle potential in finite nuclei. (auth)

12076 (JINR-P4-2976) ODNOCHASTICHNYE UROVNI SREDNEGO POLYA DEFORMIROVANNYKH YADER. (One-Particle Levels of the Average Field in Deformed Nuclei). Gareev, F. A.; Ivanova, S. P.; Kalinkin, B. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 22p. (In Russian). Dep. mn.

A method is suggested to solve the Schrödinger equations with a diffusion potential which allows calculation of the energies and the analytical wave functions of single-particle states of a deformed axially symmetric nucleus. (auth)

12077 (JINR-P4-2981) O KULONOVSKOM VZAIMODEISTVII V YADRAKH. (On the Coulomb Interaction in Nuclei). Vagradov, G. M.; Gareev, F. A.; Kalinkin, B. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 13p. (In Russian). Dep. mn.

The correlative force effects on the Coulomb interaction of nucleons in nuclei are considered. It is shown in the approximation of the Fermi-liquid theory that taking these forces into account explains the difference in the depths of proton and neutron average fields. (auth)

12078 (JINR-P4-2985) VZAIMODEISTVIE NUKLONA NA IZOLIROVANNOM UROVNE S KVADRUPOL'NYM FONONOM. (Interaction of a Nucleon on an Isolated Level With a Quadrupole Phonon). Dzholos, R. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 14p. (In Russian). Dep. mn.

A method is suggested for an approximate treating of the nucleon-phonon interaction, by the example of a simple model in which a nucleon interacts on an isolated level with a quadrupole phonon. This method is used to investigate different solutions which were obtained earlier by other authors. It is shown that not all of these solutions are correct. (auth)

12079 (JINR-P4-3070) O REAKTSIYAKH DEITRONNOGO SRYVA NA DEFORMIROVANNYKH YADRAKH. (On Deuteron Stripping Reactions on Deformed Nuclei). Luk'yanov, V. K.; Petkov, I. Zh. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 9p. (In Russian). Dep. mn.

Deuteron stripping reactions on deformed nuclei are considered in the adiabatic approximation in the framework of a distorted wave method. The selection rules are obtained. The method of treating experimental data which is applied in the analysis is not a precise one. (auth)

12080 (LYCEN-6634) ELABORATION D'UN PROGRAMME DE CALCUL D'ONDES DISTORDUES APPLICATION A CERTAINES REACTIONS DE STRIPPING. (Elaboration of the Program of Distorted Wave Calculation; Application to Various Stripping Reactions). Lamot, Georges (Lyon Univ. (France). Faculte des Sciences). May 12, 1966. 86p. (In French). Dep. mn.

Thesis.

The distorted-wave calculation plays a basic role in elastic scattering processes. This process is represented by means of interactions expressed with complex potentials. The hypotheses leading to the introduction of this type of potential in the study of nuclear reactions are reviewed. The cross section and the polarization of a particle scattered elastically by a nucleus are calculated. The stripping cross section is then calculated, using a classical analytical method and a graphic method. The results are applied to the numerical calculation of X(d,p)Y reactions. (J.S.R.)

12081 (ORNL-TM-1709) MULTIPOLE EXPANSION OF THE WOODS-SAXON POTENTIAL: THE CODE LYNNE. Johnson, M. B. (Oak Ridge National Lab., Tenn.). Dec. 7, 1966. Contract W-7405-eng-26. 17p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A FORTRAN code was written for the IBM-7090 which performs a multipole expansion of the Woods-Saxon potential. The numbers generated are suitable for microscopic calculations of inelastic scattering from nuclei which use a Woods-Saxon interaction between the projectile and the target nucleons. In particular, the scattering of alpha particles is considered. LYNNE is written to be compatible with the code ATHENA which calculates micro-

scopic form factors using single-particle wave functions. Although LYNNE is written specifically for the Woods-Saxon potential, the code could be modified to accept other potentials. (auth)

12082 (ORO-2791-20) TRNRX: A FORTRAN PROGRAM FOR GAMMA RAY ANGULAR DISTRIBUTIONS IN (n,n'γ) REACTIONS WITH MOLDAUER'S WIDTH FLUCTUATION CORRECTIONS. Mathur, S. C.; Buchanan, P. S.; Morgan, I. L. (Texas Nuclear Corp., Austin). Aug. 1966. Contract AT(40-1)-2791. 52p. Dep. mn. CFSTI $3.00 cy, 10.65 mn.

A computer program (TRNRX) for the calculation of gamma angular distribution and production cross sections for neutron inelastic scattering, taking into account Moldauer's width fluctuation corrections, is described. (D.C.W.)

12083 (PUC-937-233) SHELL MODEL CALCULATIONS OF NUCLEI FROM A = 6 TO 45 USING THE HAMADA-JOHNSTON POTENTIAL. Halbert, E.C.; Kim, Y.E.; McGrory, J.B. (Oak Ridge National Lab., Tenn.); Kuo, T.T.S. (Princeton Univ., N.J.). Sept. 1966. Contract AT(30-1)-937. 10p. (CONF-660906-46). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Conference on Nuclear Physics, Gatlinburg, Tenn.

An effective interaction obtained from the Hamada-Johnston potential is used to calculate shell-model spectra of nuclei with A = 6 to 45. In some of these cases, core-polarization effects are introduced through a renormalization of the interaction. Some electromagnetic moments and transitions of p-shell nuclei are calculated. In general, the results throughout this region are encouraging. (auth)

12084 (UCRL-16322) EXTENDED CHARGE EFFECTS ON LOW ENERGY PROTON-PROTON SCATTERING. Slobodrian, R. J. (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1965. Contract W-7405-eng-48. 13p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A nonnegligible correction to the proton–proton scattering parameters was found to arise from a consideration of the extended charge distribution of the proton, far beyond the errors quoted in the recent literature. Using the physical picture given, it is concluded that the p–p nuclear potentials should be less attractive than is currently assumed. This is due to a fictitious singular electrostatic potential, which simulates a repulsive core inside the nuclear potential well. (S.F.L.)

12085 POSSIBLE ANGULAR MOMENTA OF A SYSTEM OF FERMIONS OR BOSONS WITH SPIN j. Buettner, H. (Univ., Frankfurt am Main). Z. Phys., 198: 494-507(1967).

Simple recurrence relations for the multiplicities of angular momenta are presented for a system of fermions or bosons with spin j. Tables are given for fermions with $j = {}^{13}/_{2}$ up to ${}^{19}/_{2}$ and for bosons with j = 2, 3, 4, 5 and 20 particles at most. (auth)

12086 NUCLEON–NUCLEON–DEUTERON VERTEX. Dosch. Hans Guenter (Univ., Heidelberg. Kernforschungszentrum, Karlsruhe, Ger.). Z. Phys., 198: 461-76(1967).

The definition of a "dispersion theoretical nucleon-nucleon-deuteron vertex function" is given. This function is calculated with the help of the one boson exchange model. (auth)

12087 POTENTIAL ENERGY SHIFT FOR A SCREENED COULOMB POTENTIAL. Garrett, W. R. (Oak Ridge National Lab., Tenn.); Bhalla, C. P. Z. Phys., 198: 453-60(1967).

Utilizing Hartree-Fock self-consistent field wave functions, accurate values of the potential energy shift at the nucleus due to atomic electrons have been determined for a large number of atoms. An extensive numerical table of values of the shift, V_0, is given and comparison is made with earlier approximate results obtained from the Thomas-Fermi and Thomas-Fermi-Dirac statistical models and with estimates from K binding energy data. In the calculation of screening corrections to Fermi functions, the Hartree-Fock results present a considerable improvement over earlier estimates from the aforementioned methods. (auth)

12088 LOW MOMENTUM TRANSFER NEUTRON FORM FACTORS FROM ANALYSIS OF DEUTERON ELECTRODISINTEGRATION. Braess, D.; Hasselmann, D.; Kramer, G. (Physikalisches Staatsinstitut, Hamburg). Z. Phys., 198: 527-37 (1967).

Electromagnetic form factors of the neutron are calculated from recent inelastic e-d-scattering measurements which were performed at the quasi-elastic peak and at momentum transfers below 5 f^{-2}. The theory used in the analysis includes a realistic description of the deuteron structure and of the effect of interactions between the outgoing nucleons. It is found that the rescattering corrections are very important in this region of momentum transfer. Concerning the charge form factor G_{2E} of the neutron, it is concluded that meaningful results cannot be given at the moment. The magnetic form factor of the neutron G_{2M}/μ_2 comes out still larger than but closer to the magnetic form factor G_{1M}/μ_1 of the proton compared to former analyses. More measurements around $q^2 = 1\ f^{-2}$ seem to be very interesting in this respect. (auth)

12089 SYMMETRY AND COULOMB TERMS IN THE PROTON OPTICAL POTENTIAL. Hodgson, P. E. (Oxford Univ.). Can. J. Phys., 45: 449-51(Feb. 1967).

The most reliable phenomenological analyses give a value of the symmetry term very similar to that of Perey and also establish the presence of the Coulomb term. The accuracy of this determination is sufficient to justify Perey's method of calculating the magnitude of the Coulomb term from the value of dV/dE (i.e., 0.3) appropriate to scattering from nuclei with no appreciable coupling between elastic and inelastic channels rather than from the average value of 0.55 found phenomenologically from analyses of nuclei for which this coupling is appreciable. (F.S.A.)

12090 TABLES AND GRAPHS FOR THE DETERMINATION OF ANGULAR CORRELATION FUNCTIONS. Badica, T.; Deciu, N. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 11: 477-88(1966).

Tables were calculated for coefficients A_k of the angular correlation function as a function of δ in the following conditions: $1/2 \leq I_1, I, I_2 \leq {}^{11}/_{2}$ (the integral and the half-integral values), k = 2,4 and $L_\nu = 1,2$. (auth)

12091 PRIMAKOFF PLOT OF MUON CAPTURE IN COMPLEX NUCLEI. Rho, M. (Univ. of Virginia, Charlottesville. CEN, Saclay, Gif-sur-Yvette, France). Phys. Lett., 24B: 81-3 (Jan. 23, 1967). (ORO-2915-68).

An argument analogous to that used for the description of the giant resonance phenomenon in the Fermi gas model is presented to explain the Primakoff plot of muon capture in complex nuclei. (auth)

12092 SHELL EFFECTS IN THE EXCITATION OF 0^+ STATES BY (t,p) REACTIONS. Glover, R. N. (Atomic Weapons Research Establishment, Aldermaston, Eng.); McGregor, A. Phys. Lett., 24B: 97-9(Jan. 23, 1967).

It is shown that the strength of the excited 0^+ states observed in (t,p) reactions is dependent on the shell-model level order rather than merely on pairing effects. (auth)

12093 ANALYSIS OF DATA FROM REACTIONS OF THE FORM $A + B \rightarrow a_1 + a_2 + a_3$. Assimakopoulos, P. A.; Gangas, N. H. (Democritus Nuclear Research Center, Athens). Nucl. Instrum. Methods, 47: 260-4(1967).

The advantages and shortcomings of the various methods, currently in use for drawing information from and presentation of data of complete experiments on nuclear reactions with three particles in the final state, are briefly considered. A new method for handling data from such experiments is presented. (auth)

12094 POLARIZATION PHENOMENA FOR SPIN-1/2 AND SPIN-1 PARTICLES. Nurzynski, J. (Australian National Univ., Canberra). Austral. J. Sci., 29: 119-24(Nov. 1966).

Some actual problems relating to polarization phenomena observed in elastic scattering are discussed and new trends in experimental studies are indicated. The discussion will include both spin-1/2 and spin-1 particles. The importance of the polarization measurements and the information they can provide have been discussed in earlier papers (Huber and Meyer, eds., 1961) and no attempt is made here to review these topics in full detail. (auth)

12095 THE LIMIT OF IDENTIFICATION FOR SHORT-LIVED RADIOISOTOPES IN ACTIVATION ANALYSIS. THE LIMIT OF MEASUREMENT OF HALF-LIFE. Sterlinski, S. (Inst. of Nuclear Research, Warsaw). Nucl. Instrum. Methods, 47: 329-41 (1967).

A study was made of the identification for short-lived radioisotopes of low activity when the statistical fluctuation of counts from the effect and background slurs the univocality of the measured gamma-radiation energy (E_γ) and half-life ($T_{\frac{1}{2}}$). On the basis of theoretical analysis and experimental data, indications were formulated how to organize the measurement of $T_{\frac{1}{2}}$ to obtain the optimum accuracy of the estimate of this value. A formula and plots are presented for calculating the limited counting rate of the effect (i.e., the limited activity), at which the expected value of the accuracy of the estimate of $T_{\frac{1}{2}}$ can be obtained in a reasonably organized measurement. It was found experimentally that the limited activity for the measurement of $T_{\frac{1}{2}}$ is simultaneously sufficient for an adequately accurate estimate of the gamma energy radiation. The present investigation was undertaken primarily with the object of spectrometric measurements but some conclusions can also be applied in measurements of total activities. (auth)

12096 NEUTRON–PROTON PAIRING AND COLLECTIVE VIBRATIONS IN NUCLEI. Brandus, Ioan (Inst. of Atomic Physics, Bucharest); Dumitrescu, Ovidiu. Rev. Roum. Phys., 11: 531-3(1966).

A treatment is given of nuclear interactions in which the neutron-proton pairing and the long-range residual interaction are simultaneously taken into account by means of the generalized Bogoliubov transformation. The collective vibrational nuclear motion is also studied in the random-phase approximation. (S.F.L.)

12097 EFFECT OF CROSS RELAXATIONS ON NUCLEUS POLARIZATION. Mekhtiev, G. F. Uch. Zap. Azerb. Gos. Univ., Fiz. Mat. Nauk, No. 5, 83-5(1964). (In Russian).

The probability of cross-transition caused by spin dipole-dipole interaction in which two neighboring e spins change their orientation mutually so that the total nuclear polarization decreases was calculated. In this case an energy equal to the nuclear Zeeman quanta can be absorbed by the electron dipole-dipole reservoir. A general expression for nuclear polarization with consideration of cross-relaxation is given; the polarization decreases with acceleration of cross-relaxation transitions. (auth)

12098 SAHA INSTITUTE OF NUCLEAR PHYSICS ANNUAL REPORT 1965. Calcutta, Saha Inst. of Nuclear Physics, 1965. 122p.

Research programs and progress in experimental and theoretical nuclear physics, elementary-particle physics, biochemistry, biophysics, solid-state physics, and chemistry are summarized, together with the development of electronic instrumentation. (D.C.W.)

12099 SINGLE-PARTICLE POTENTIALS AND WAVE FUNCTIONS IN THE 1p AND 2s-1d SHELLS. Elton, L. R. B. (Univ. of Surrey, London); Swift, A. Nucl. Phys., A94: 52-72(Mar. 1967).

Wave functions were generated in a parametrized single-particle local potential. The parameters were adjusted to fit the shape of the wave functions to elastic electron scattering data, and the eigenenergies were adjusted to the proton separation energies, as obtained from (p,2p) and similar experiments. In this connection, the points at which the model breaks down are of particular interest from the point of view of individual nuclear properties. The relation between the single-particle wave functions and the overlap integrals of the initial and final states in the (p,2p) reaction is discussed, and it is shown that the single-particle wave equation is a first approximation to the Schrödinger equation for the overlap integrals. Finally, it is found that the local potential which is energy dependent is equivalent to an energy independent nonlocal potential in the effective mass approximation. (auth)

12100 FINE STRUCTURE AND NEUTRON DECAY OF THE ISOBARIC ANALOGUE RESONANCES. Mahaux, C. (Univ., Heidelberg. Univ. of Liege); Weidenmueller, H. A. Nucl. Phys., A94: 1-25(Mar. 1967).

The mechanism of the distribution of an isobaric analog resonance over its fine structure peaks is studied in the frame of the shell-model theory of nuclear reactions. A two-channel model is constructed, where the isobaric analogue doorway state is dominated by the entrance proton channel which, in turn, is coupled to the outgoing neutron channel only via complicated shell-model states. The energy averages of the differential elastic scattering, total, and reaction cross sections are calculated. It is shown that these averages do not display the same resonance energies and widths, unless the background of the (p,n) cross section reaches its maximum value. This holds in spite of the fact that the diagonal and off-diagonal S-matrix elements have the same poles. The elastic, scattering, and total cross sections in the absence of the isobaric analogue resonance are studied from a microscopic point of view, and the connection with the phenomenological optical-model treatment is given. The extraction of the spectroscopic factor from the experimental data is discussed. The fluctuations of the differential elastic scattering cross section around its average are investigated. The distribution of the fine structure resonance parameters is derived for overlapping as well as isolated peaks; the results are compared with the experimental data obtained at Duke University for the reaction $^{40}Ar(p,p)^{40}Ar$. (auth)

12101 A THEORY OF ISOBARIC SPIN ANALOGUE RESONANCES. Stephen, R. O. (Univ. of Washington, Seattle). Nucl. Phys., A94: 192-204(Mar. 1967).

A theory of isobaric spin analogue resonances is formulated using Feshbach unified theory of nuclear reactions. The analysis is applicable to both elastic and inelastic scattering of protons from analogue resonances; explicit formulas are given for the elastic and inelastic amplitudes. The mixing of analogue states with "normal" states is also considered in detail and formulas for the transition amplitudes including mixing are given. (auth)

12102 ANTISYMMETRIZED DISTORTED-WAVE APPROXIMATION FOR NUCLEON–NUCLEUS SCATTERING. Amos, K. A. (Univ. of Pittsburgh, Pa.); Madsen, V. A.; McCarthy, I. E. Nucl. Phys., A94: 103-28(Mar. 1967).

Inelastic reactions between nucleons and nuclei are discussed using quasi-three-body matrix elements computed in the distorted-wave t-matrix approximation. In this approximation the reaction amplitude is the matrix element of the two-nucleon t-matrix in a distorted-wave representation. Antisymmetry between the nucleons in the entrance and exit channels is taken into account, and a local, spin-dependent model is used for the t-matrix. Single-particle matrix elements are computed as examples. It is shown that space-exchange matrix elements and direct matrix elements are comparable in magnitude and are approximately in phase. Properties of each are discussed in detail. Comparison of the theory with an $^{89}Y(p,p')$ experiment shows that cross sections of roughly correct magnitude are obtained with no free parameters. (auth)

12103 MULTIPOLE SUM RULE ANALYSIS OF SINGLE-NUCLEON TRANSFER REACTIONS ON ^{51}V. Moinester, Murray A. (Univ. of Rochester, N. Y.). Nucl. Phys., A94: 81-94(Mar. 1967). (UR-875-168).

The formalism of the recently developed multipole sum rules for single-nucleon transfer reactions is reviewed. These rules are then applied in detail to available data for a ^{51}V target. From the dipole sum rule, the spin and magnetic dipole moment of ^{51}V are determined; good agreement between the direct-reaction deduced values and the known values is obtained. The energy-weighted sum rules are also employed to demonstrate the manner in which information about the residual interaction can be extracted from spectroscopic data. The analysis clearly displays the structure of these sum rules. (auth)

12104 DEUTERON OPTICAL-MODEL POTENTIAL. Coffou, E.; Goldfarb, L. J. B. (Univ. of Manchester, Eng.). Nucl. Phys., A94: 241-56(1967).

The lowest-order approximation to the deuteron optical-model potential is evaluated analytically in terms of the neutron and proton optical-model parameters with a view to singling out the particular role played by the internal structure of the deuteron. The results for the real part of the potential agree strikingly well with those derived from explicit numerical computation, and there is a strong similarity with the potential derived from phenomenological analyses of deuteron elastic scattering. The treatment is, however, less consistent as regards the imaginary part of the potential. (auth)

12105 AVERAGE SEPARATION ENERGY OF STRONGLY BOUND NUCLEONS. Brink, D. M. (Oxford Univ.); Sherman, N. Nucl. Phys., A94: 385-407(1967).

The separation energy of a strongly bound nucleon from a light or medium-weight nucleus was calculated in terms of a general two-body nucleon-nucleon interaction potential. It is assumed that the nuclear wave function can be approximated by a linear combination of a few Slater determinants. Single-particle wave functions are approximated by harmonic oscillator wave functions. Simple formulas, which contain only a few potential matrix elements, are derived for the separation energies, and numerical results are presented for several choices of the nucleon-nucleon interaction potential. (auth)

12106 DAMPING OF SINGLE-PARTICLE WAVE FUNCTIONS IN THE ALPHA-PARTICLE INTERIOR DUE TO EXCHANGE EFFECTS IN NON-LOCAL POTENTIALS. Schenter, R. E. (Case Inst. of Tech., Cleveland. Battelle-Northwest, Richland, Wash.). Nucl. Phys., A94: 408-16(1967).

The spatial dependence of the single-particle wave function describing the elastic scattering of low-energy neutrons from helium nuclei was calculated. Use was made of a nonlocal, optical-model potential formally derived within the framework of the "no-polarization" approximation in terms of the nucleon-nucleon interaction and the ground-state wave function of the target. Emphasis was on properly including all exchange terms in the optical potential. It was found that the use of this nonlocal potential leads to a single-particle wave function with values in the alpha-particle "interior" greatly reduced from that given by an "equivalent" local potential ($\psi_{NL} \approx 0.2\ \psi_L$). This reduction occurred for all energy cases considered (incident neutron energies of 1.3 to 32 MeV). The damping appeared only when all exchange terms were included in the nonlocal potential as calculations which used only the "direct" exchange terms gave rise to a wave function essentially identical to that of the local potential. (auth)

12107 SHELL MODEL CALCULATION OF CHANGES IN BINDING ENERGIES AND SHELL MODEL TREATMENT OF SPURIOUS STATES. Lee, Chong Wan. Pittsburgh, Univ. of Pittsburgh, 1965. 198p.

Thesis.

The changes in neutron separation energies as nucleons are added to a nucleus were calculated for the Ca and Zr isotopes

starting from a shell model Hamiltonian with a local two-body force. These nuclei were described to first-order as pure j-j configurations. Effects due to configuration mixing were treated by second-order perturbation theory. The parameters of the force were chosen to fit the parameters which Talmi and Unna extracted with their analysis of ground-state binding energies. It was found that the single-hole energies of ^{47}Ca and ^{95}Zr were very sensitive to the exchange mixture of the central force. Using only a central force, the $f_{\frac{7}{2}}$ to $f_{\frac{5}{2}}$ splitting in Ca and the $d_{\frac{5}{2}}$ to $d_{\frac{3}{2}}$ splitting in Zr were found to decrease as the $f_{\frac{5}{2}}$ and $d_{\frac{3}{2}}$ shells were filled, while experimentally they increase. Inclusion of the odd tensor force increased the calculated splitting. Also a strong attractive even tensor force was used in calculating the changes in neutron separation energies as a proton shell is filled, and reasonable agreement with the experimental data was found. The energy spectra of ^{42}Ca, ^{92}Zr, and ^{18}O, as well as the binding-energy parameters of Talmi and Unna, were calculated with realistic interactions which fit the two-nucleon scattering data. Both the velocity-dependent interaction given by Green and the nonlocal interaction given by Tabakin were used. Inclusion of configuration mixing made the J = 0 state in the two-body energy spectra lowest, but did not lower it to its experimental value. A simple method for generating the spurious states, which arise from the incorrect treatment of the center-of-mass motion by nuclear shell model calculations, is also given. It is shown which j-j configurations have no spurious states. Once the spurious state is known, non-spurious states have been constructed by subtracting the spurious part from a particular excited shell-model state and renormalizing. By dividing out the center-of-mass motion, a wavefunction depending only on internal coordinates was obtained which can be ascribed a cluster motion. The center-of-mass effects based on these cluster wavefunctions lead to the appearance of a correction factor in the radiative transitions to the ground state. Unfortunately they leave the small s-doublet splitting in ^{11}B unexplained. (Distr. Abstr.)

12108 OPTICAL ANALYSIS OF POTENTIAL WELL RESONANCES. McVoy, K. W. (Univ. of Wisconsin, Madison); Heller, L.; Bolsterli, M. Rev. Mod. Phys., 39: 245-?(Jan. 1967).

As a contribution toward the understanding of resonant scattering in general, the potential-barrier resonances which occur in a variety of simple one- and two-channel S-wave scattering problems are examined. The models chosen have familiar optical analogs which, together with the appealingly simple analytic properties of their scattering amplitudes, facilitate a unified discussion of such diverse phenomena as the peculiar S-wave "resonances" of a square potential well, the occurrence of "resonance circles" in both elastic and inelastic scattering amplitudes, and the large nonresonant maxima which the descent of the background phase (as a function of energy) can produce in total cross sections. (auth)

12109 THE TEST OF THE POLE MECHANISM IN DIRECT NUCLEAR REACTIONS A(x,y)B. Ali-Beidovi, M. M.; Blokhintsev, L. D.; Dolinskii, E. I.; Turovtsev, V. V. (Moscow State Univ.). Yadern. Fiz., 4: 1122-30(Dec. 1966). (In Russian).

Criteria are suggested for an experimental testing of the pole mechanism in the direct nuclear reactions $x + A \rightarrow y + B$. Applications of these criteria to particular nuclear reactions are considered. (auth)

12110 EXACT CALCULATION OF DEUTERON ELASTIC SCATTERING AND THE STRIPPING REACTION AS A SPECIFIC CASE OF THE THREE-BODY PROBLEM. Baz, A. I.; Demin, V. F.; Kuzmin, I. I. Yadern. Fiz., 4: 1131-3(Dec. 1966). (In Russian).

The elastic scattering of a deuteron and the stripping reaction in the field of a square well with one bound state (the 1s-level) were calculated using the exact solution method for a specific case of the three-body problem. The deuteron kinetic energy was chosen to be equal to 2.2 MeV. The results obtained are compared with those of approximate methods. (auth)

12111 THEORY OF THE QUASIELASTIC KNOCK-OUT OF PROTONS FROM NUCLEI BY THE HIGH ENERGY ELECTRONS. Meboniya, D. V.; Chiofi, K. A. (Moscow State Univ.). Yadern. Fiz., 4: 1207-9(Dec. 1966). (In Russian).

The distortion effects in the final state in the quasielastic (e,e'p) reactions are treated quasiclassically. The dependence of the reduction factors on the model parameter and on the distorting potential parameters is investigated. (auth)

12112 SYSTEMATICS OF β-DECAY ENERGIES AND PROPERTIES OF ENERGY SURFACE OF NUCLEI. Kolesnikov, N. N.; Krylova, A. P. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 2, 31-42(1966). (In Russian).

The difference in energies of two nuclei (A, Z) and (A, Z ± 1) is designated by $E^{\pm}(A, Z)$. Values of $E^{\pm}$ are considered only for even-odd (eo) and even-even (ee) nuclei in order to exclude the effect of pairing in the nucleus. The value (E_{eo}, Z) of the point of intersection of the lines $E^{-}_{eo}(Z)$ and $E^{+}_{eo}(Z)$ for a fixed (odd) A is designated by $-D_{eo}$, Z^{0}_{eo}, and the following relation holds: $E^{\pm}_{eo}(Z) = \pm\alpha^{\pm}_{eo}(Z - Z^{0}_{eo}) - D_{eo}$. Here $\alpha_{\pm}$ is the slope of the line obtained on plotting E^{+} or E^{-} in MeV as a function of Z. The expression for even-even nuclei is analogous. Within the accuracy of the experimental error it turns out that the values of α^{ee}_{+}, α^{eo}_{+}, α^{ee}_{-}, α^{eo}_{-}, D_{eo} and D_{ee} are independent of A. On plotting values of $E^{\pm}$ of all even-even and even-odd nuclei as a function of $Z - Z^{0}$ for the region Z > 82, N > 126 (N = number of neutrons), all the experimental points (about 150) fall on a straight line with an error of not more than ±0.2 MeV. The beta decay energy of any nucleus with a value of A > 40 can be calculated with the use of the proper parameters, if a magic number of N and Z is not involved (20, 28, 50, 82 or 126), and if a region of a sharp change in deformation is not encountered (N = 88 to 89 and N = 129 to 130). (TTT)

12113 INTERACTION BETWEEN LIGHT HYPERNUCLEI AND NUCLEI. Kolesnikov, N. N.; Vedrinskii, R. V. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 2, 25-31(1966). (In Russian).

Light hypernuclei (A < 5) are weakly bound systems with a Λ binding energy of <3.5 MeV. Hence, on colliding with a nucleus, splitting of the hypernucleus can take place with or without capture of the Λ-particle by the scattering nucleus. The cross section for Coulomb scattering of hypernuclei with A = 4 and 5 was estimated to be small with a value of 10^{-25} to 10^{-26} cm^2. The binding energy of the $_{\Lambda}H^3$ is anomalously small at ~0.2 MeV so that the cross-section for Coulomb splitting turns out to be very large, especially at high Z values. An expression is given for the cross section σ as a function of energy E and of atomic number Z. Coulomb splitting begins at $E > 0.3\ (Z)^{0.5}$, attains a maximum, and falls to a limiting value of $\sigma = 12Z^2/E\ (10^{-26})$ cm^2. The formula for the splitting cross section in a Coulomb field can be used to estimate the value of σ over a range of Z and E values, as shown by independent checks. The capture of free hyperons (Λ) by various nuclei is estimated. A value of σ = 1.8 barns is obtained for the capture of 5-MeV Λ particles by silver nuclei. The energy distribution of neutrons evaporated from the intermediate compound nucleus is estimated. (TTT)

12114 CALCULATION OF ft VALUES FOR SUPERALLOWED $0^+ - 0^+$, T = 1, ΔT = 0β^+ TRANSITIONS AND THE VALUE OF THE VECTOR INTERACTION CONSTANT G_V IN β DECAY. Suslov, Yu. P. (Leningrad State Univ.). Yadern. Fiz., 4: 1187-90(Dec. 1966). (In Russian).

The ft values for a number of superallowed β^+ transitions are calculated using a self-consistent atomic potential, taking the finite dimensions of the nucleus into account. The average ft value for transitions in the nuclei ^{14}O, ^{26}Al, ^{34}Cl, ^{42}Sc, ^{46}V, ^{50}Mn, and ^{54}Co is equal to ft = 3113 ± 7 sec. The value $G_V = 1.4057 \pm 0.0016 \times 10^{-49}$ erg · cm^3 is obtained for the vector interaction constant in β decay. The difference between the constants G_μ and G_V is equal to $(G_\mu - G_V)/G_\mu = 2.04 \pm 0.12\%$. The errors are based on deviations from the average value and the uncertainties in the radiative corrections. (auth)

12115 HADRONLIKE BEHAVIOR OF γ,ν-NUCLEAR CROSS SECTIONS. Stodolsky, L. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 18: 135-7(Jan. 23, 1967).

It is explained how high-energy photon- or neutrino-nucleus reactions can exhibit an A dependence like that expected from a strongly interacting particle. The condition for this is a relation among the nucleon amplitudes implying that the total photon cross section on the nucleon is equal to a certain sum over forward vector-meson production amplitudes. This relation is compatible with presently available data. (auth)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 11183, 11190, 11191, 11270, 12219, and 12231.

12116 (AAEC-E-153) A SURVEY OF THERMAL AND MECHANICAL ASPECTS OF SOME H.T.G.C. REACTOR CORE DESIGNS UTILISING BERYLLIUM OXIDE MODERATION. Gerrand, R. P.; Holy, Z. J.; Binns, I. M.; Hawker, P. A. E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). June 1966. 43p. Dep. mn.

Results are presented of a study made from July 1962 to June 1963 of various reactor core configurations for a high-temperature gas-cooled reactor system, using fuels dispersed in unclad BeO with BeO moderation and CO_2 gas coolant. The configurations are naturally classified into two groups: one, Parallel-Channel Reactors (cores with fixed internal geometry and specific coolant channels), and the other, Pebble-Bed Reactors. The major advantages and design problems of each type are discussed. Methods for solution of the problems are suggested. Although the reactor types are compared, it is impossible to recommend any one type in preference to the others, owing to the lack of reliable nuclear and cost data. (auth)

12117 (ACNP-66570) SUPERHEATER FUEL THERMOCOUPLE CALIBRATION TESTS (711A) AND RADIATION COOLING TESTS (723). Kintner, L. L.; Green, G. S. Jr.; Kelly, J. P.; Myers, L. B. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Nov. 1966. Contract AT(11-1)-589. 70p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Northern States Power Co., Minneapolis, Minn. and Central Utilities Atomic Power Associates.

The superheater fuel thermocouple calibration tests and radiation cooling tests are reported in connection with the research and development design of the Pathfinder Atomic Power Plant. In an arrangement of five instrumented fuel elements in the superheater core, four are in positions having the highest heat generation and one is in the center. Two of the elements have thermocouple hot junctions located primarily to measure temperatures during radiation cooling when peak temperatures are occuring near the core vertical center. Three of the elements have hot junctions located primarily to measure temperatures during steam cooling when peak temperatures are expected to occur near the outlet end of the fuel elements. Calculations of thermocouple temperatures include fuel element surface temperature for radial heat flow through the element, heat generation distribution, and thermocouple hot junction temperature relative to fuel surface temperature. Calculated and experimental results are compared. The data for calculating temperatures following reactor shutdown are given. (J.C.W.)

12118 (APDA-NTS-8) FLUX MAPPING MEASUREMENTS TO DETERMINE THE LOCATION OF THE PERMANENT DETECTORS IN THE ENRICO FERMI REACTOR. Page, E. M.; Horne, R. E. (Atomic Power Development Associates, Inc., Detroit, Mich.). Sept. 1966. 71p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

The axial distribution of the relative ^{10}B (n,α) response was obtained in all six of the neutron counter tubes which are located in the graphite shield and which are designed to contain the permanent plant instrumentation. The axial distribution of the relative ^{235}U fission response in counter tubes numbers 2, 3, and 4 was obtained as well. Measurements were also made of the effect of wrapping the detectors with Cd absorber material and polyethylene moderator material. The absolute response of each type of permanent plant neutron detector (B-lined ion chambers and ^{235}U fission counters) was then obtained at a known power level for at least one position in the counter tubes of interest. The two sets of data were combined and analyzed and the results were used to locate each of the thirteen neutron detectors to be used for permanent plant operation. In addition, the data were used to determine the Sb–Be neutron source size needed to produce a minimum of 10 cps at shutdown on source range channels 1 and 2. The source size obtained was 743 curies. Finally, the shutdown γ radiation level in all of the neutron counter tubes was measured following a period of short-term low-power reactor operation. These data were extrapolated to obtain the expected shutdown γ radiation levels following long-term operation at full power, and it was verified that neither the source range or intermediate range channels would be adversely affected by γ interference during reactor startup. A similar analysis was also made of the effect of γ radiation on the operation of the Power Range channels using operational γ radiation data which had been determined as part of the shield test program. (auth)

12119 (CVNA-267) CAROLINAS VIRGINIA NUCLEAR POWER ASSOCIATES, INC. RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report, April–June 1966. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Contract AT(30-1)-2289. 106p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Operation and development of the Carolinas-Virginia Tube Reactor is summarized. Information is included on plant radiation monitoring, coolant chemistry, core operation, plant nuclear engineering and evaluation, ultrasonic inspection of pressure tubes, CVTR irradiation testing at high power and high burnup, and reactor safety. (J.R.D.)

12120 (DLCS-5000165) QUARTERLY OPERATING REPORT [OF SHIPPINGPORT ATOMIC POWER STATION], FIRST QUARTER 1965. (Duquesne Light Co., Shippingport, Pa.). Contract AT(11-1)-292. 43p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Activities during the period January 1 through March 31, 1965, were concerned with final preparations and testing for Core 2 power operations. Fifty four tests were performed to verify the operability and integrity of the various plant components and systems. Separate sections discuss operations, refueling, maintenance, test programs, training program, and construction and modifications. (H.D.R.)

12121 (DLCS-5000166) QUARTERLY OPERATING REPORT [OF SHIPPINGPORT ATOMIC POWER STATION], FIRST QUARTER 1966. (Duquesne Light Co., Shippingport, Pa.). Contract AT(11-1)-292. 28p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Significant operations, occurrences, and other Shippingport station activities during the period January 1 through March 31, 1966, are summarized. Core 2 blanket and Core 2 Seed 1 operating time at the end of the report period was 3,694 EFPH. Separate sections discuss operations, refueling, maintenance, test programs, training program, and construction and modifications. (H.D.R.)

12122 (DLCS-5000265) QUARTERLY OPERATING REPORT [OF SHIPPINGPORT ATOMIC POWER STATION], SECOND QUARTER 1965. (Duquesne Light Co., Shippingport, Pa.). Contract AT(11-1)-292. 46p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Significant operations, occurrences, and other activities for the period April 1 through June 30, 1965, are summarized. Final preparations and testing were completed and power operation with Core 2 Seed 1 was initiated on April 30. Core 2 blanket and Core 2 Seed 1 operating time at the end of the report period was 727 EFPH. Separate sections discuss operations, refueling, maintenance, test programs, training program, and construction and modifications. (H.D.R.)

12123 (DLCS-5000266) QUARTERLY OPERATING REPORT [OF SHIPPINGPORT ATOMIC POWER STATION], SECOND QUARTER 1966. (Duquesne Light Co., Shippingport, Pa.). Contract AT(11-1)-292. 21p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Significant operations, occurrences, and other activities for the period April 1 through June 30, 1966, are summarized. Total Core 2 blanket and Core 2 Seed 1 operating time at the end of the report period was 4,858 EFPH. Separate sections discuss operations, station performance, plant chemistry, refueling, maintenance, and test programs. (H.D.R.)

12124 (DLCS-5000365) QUARTERLY OPERATING REPORT [OF SHIPPINGPORT ATOMIC POWER STATION], THIRD QUARTER 1965. (Duquesne Light Co., Shippingport, Pa.). Contract AT(11-1)-292. 34p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The significant operations, occurrences, and other Shippingport station activities during the period July 1, 1965, through September 30, 1965, are summarized. Core 2 blanket operating time and Core 2 Seed 1 operating time at the end of the report period was 2,045 EFPH. Separate sections discuss operations, refueling, maintenance, test programs, training program, and construction and modifications. (H.D.R.)

12125 (DLCS-5000366) QUARTERLY OPERATING REPORT [OF SHIPPINGPORT ATOMIC POWER STATION], THIRD QUARTER 1966. (Duquesne Light Co., Shippingport, Pa.). Contract AT(11-1)-292. 25p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Significant operations, occurrences, and other activities for the period July 1 through September 30, 1966, are summarized. Core 2 blanket and Core 2 Seed 1 operating time at the end of the report period was 5,875 EFPH. Separate sections discuss operations, station performance, plant chemistry, refueling, maintenance, and test programs. (H.D.R.)

12126 (DLCS-5000465) QUARTERLY OPERATING REPORT [OF SHIPPINGPORT ATOMIC POWER STATION], FOURTH

QUARTER 1965. (Duquesne Light Co., Shippingport, Pa.). Contract AT(11-1)-292. 39p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Significant operations, occurrences, and other Shippingport station activities during the period October 1 through December 31, 1965, are summarized. Core 2 blanket and Core 2 Seed 1 operating time at the end of the report period was 2,473 EFPH. Separate sections discuss operations, refueling, maintenance, test programs, training program, and construction and modifications. (H.D.R.)

12127 (EUR-3067,d) KERNKRAFTWERK GUNDREMMINGEN (KRB). JAHRESBERICHT 1965. (Gundremmingen (KRB) Nuclear Power Plant, Annual Report, 1965). (Kernkraftwerk RWE-Bayerwerk G.m.b.H., Gundremmingen (West Germany)). Sept. 1966. 51p. (In German). Dep. mn.

Construction of the Gundremmingen nuclear power plant was largely completed, the concrete shell fitted round the reactor containment, and the internal finishing work virtually terminated. All the major components were delivered during the period covered by the report, so that assembly work progressed well. The pressure vessel arrived at the site in the middle of the year, and installation of the nuclear circuits in the reactor building was completed by the end of the year. Assembly of the turbine was finished on schedule in October. The first trial run of the turboset took place at the end of October, no defects being revealed. By the end of 1965 almost all the construction work had been terminated. The final completion of the installation now depends on the work on the nuclear part, such as the blowing-out of the steam lines, the primary system pressure test, the insertion of the control rods and fuel in the pressure vessel, and the various pre-commissioning tests. The power plant should go into full-power operation in autumn 1966. In order to prepare the operating permit, the licensing authorities and the Technical Inspection Authority were kept constantly informed about the design of the plant. All the documents required for the safety assessment were forwarded to the Technical Inspection Authority during the year. The licensing procedure with regard to the water supply laws was completed, and KRB and the suppliers were informed to this effect. The permit for the transportation and storage of the fuel was granted. The planned staff of 100 has been engaged for operation of the installation. A provisional manual of operations was drawn up by the KRB staff with the help of the suppliers. (auth)

12128 (EURAEC-1699) RESEARCH ON CYCLONES FOR STEAM SEPARATION IN BOILING WATER REACTORS. Quarterly Report No. 2, April 1-June 30, 1966. (Kernenergieanlagen, Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main (West Germany)). Contract 083-66-1-TEED. 46p. (EUR-2886). Dep. mn, CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

Experimental investigations were carried out on the use of drop type cyclones to keep free of bubbles the water refluxing through the dropping space of boiling water reactors. The cyclones were developed during previous experiments with air/water mixtures and tested with high-pressure steam/water mixtures under reactor conditions. In this period the results of the steam/water experiments were analyzed to determine how and to what extent the results of air/water experiments at low pressures and temperatures can be applied to high-pressure steam/water mixtures. In order to obtain the most reliable results, the air/water experiments were conducted in the test rig with the same geometry that was used in the steam experiments. (H.D.R.)

12129 (EURAEC-1760) RESEARCH PROGRAM FOR THE GARIGLIANO NUCLEAR POWER PLANT. Quarterly Report No. 10. (Ente Nazionale per l'Energia Elettrica, Rome (Italy). Societa Elettronucleare Nazionale, Rome (Italy)). Oct. 1, 1966. Contract 101-63-11-RDI. 16p. (EUR-3315). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

Operation of the computer system for both on-line and in off-line calculations is summarized, and the performance of instrumented assemblies in the reactor is discussed. An analysis was performed on the thermal and hydraulic data obtained in the high void tests. The values for certain basic parameters are corrected. (H.D.R.)

12130 (GA-6802) PUBLIC SERVICE COMPANY OF COLORADO PLANT: CONCEPTUAL DESIGN REPORT. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Nov. 15, 1965. Contract AT(04-3)-633. 87p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The conceptual design of the Fort St. Vrain Power Reactor to be operated by the Public Service Company of Colorado is described. The central station power plant will employ a high-temperature, helium-gas-cooled, graphite-moderated reactor utilizing a Th-U fuel cycle to supply 829 MW of thermal power for steam generation at 2400 psig and 1000°F with reheat to 1000°F. Net power output from the turbine generator will be 330 MW(e). (H.D.R.)

12131 (GAMD-4214) CONCEPTUAL DESIGN AND PERFORMANCE DATA ON ADVANCED FUEL ELEMENT CONCEPTS. Turner, R. F. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Apr. 29, 1963. Contract AT-(04-3)-167. 33p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Preliminary design concepts and the results of thermal performance analyses on advanced fuel elements being studied under the TARGET program are described. Conceptual design sketches are shown for eight advanced fuel element designs. The materials development requirements for these designs are tabulated. The results of analytical studies on the thermal performance of four of these design types are reported. In all cases considered here, the advanced fuel elements are assumed to be operating in a 1000 MW(e) high-temperature gas-cooled reactor plant. (auth)

12132 (GAMD-5632) OPERATIONAL DATA ON DECAY HEAT AND SHUTDOWN COOLING FOR THE PEACH BOTTOM REACTOR. Hopkins, G. R. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Nov. 25, 1966. Contract AT(04-3)-314. 17p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The decay heat and shutdown cooling capacities of the Peach Bottom reactor are calculated and described in this report. The primary aim of the work was to start with the design parameters, which are usually available in general form, and to evaluate these in a form suitable for ready reference from an operational point of view. This has been done for the decay heat generation and for the cooling capabilities of natural convection, of the main circulators, and of the trapping system. This information should be useful in establishing both normal and emergency operating procedures. (auth)

12133 (GAMD-7354) PEACH BOTTOM, DIFFERENTIAL ROD WORTH MEASUREMENTS AND LOADING TO 804 ELEMENTS: RESULTS OF POST CONSTRUCTION R AND D TEST PROCEDURE BP-11. Brown, J. R.; Van Howe, K. R. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Oct. 1, 1966. Contract AT(04-3)-314. 31p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The agreement between predicted and measured control rod worths is within 0.001 $\Delta\rho$ for all rod configurations. The k_{eff} of the fully loaded core as obtained from the reactivity worth of each group of fuel elements loaded as measured by the change in critical control rod position prior to the change in lumped burnable poison elements is 1.180. The k_{eff} of the fully loaded core inferred from prior measurements in the unrodded core was 1.201. These values compare with the calculated value of 1.183 ± 0.02. (auth)

12134 (GAMD-7355) REACTIVITY COEFFICIENT MEASUREMENTS IN PEACH BOTTOM: RESULTS OF POST CONSTRUCTION R AND E TEST PROCEDURES BP-7 AND BP-15. Lane, R.; Merrill, M. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Nov. 1, 1966. Contract AT-(04-3)-314. 13p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

In test BP-7, the reactivity change produced by replacing a poison dummy fuel element with a normal fuel element was measured at several radial locations by observing the change in critical rod positions. In test BP-15, the reactivity worths of U, Th, Rh, and the B lumped burnable poison were measured in the same manner by exchanging fuel elements containing different amounts of these materials. The experimental methods are described and the results are given. A series of calculations done after the experiments are described and compared with the measurements. (auth)

12135 (GAMD-7357) TEMPERATURE COEFFICIENT CALCULATIONS FOR PEACH BOTTOM. Merrill, M. H. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Sept. 1, 1966. Contract AT(04-3)-314. 26p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The temperature coefficient of the Peach Bottom HTGR has been calculated for the beginning of life core for an isothermal core and reflector over the temperature range of 300 to 700°K for various numbers of control rods inserted and an isothermal core over the temperature range of 900 to 2200°K with a constant reflector temperature of 600°K for various numbers of control rods and for several amounts of Xe-135. The first condition corresponds to the experimental measurements while the second represents the reactor at full power operation and is a prediction of the coefficients to be measured in the rise-to-power program. One purpose of the calculations was to determine what sort of agreement with experiment is possible using calculational methods typical of ordinary design studies. Although experimental results are available for the first condition, the calculations have not been extended beyond the detail would probably be employed if no measurements

had been made. The values of k_{eff} at the various temperatures were normalized to a known critical configuration with 21 rods inserted at a temperature of 522°K. The report covers all calculations made and is intended as a reference on the calculational methods. (auth)

12136 (GAMD-7358) ISOTHERMAL TEMPERATURE COEFFICIENT MEASUREMENT IN PEACH BOTTOM: RESULTS OF POST CONSTRUCTION R AND D TEST PROCEDURE CP-1. Brown, J. R.; Merrill, M. H.; Van Howe, K. R. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Oct. 1, 1966. Contract AT(04-3)-314. 17p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The measured and predicted temperature coefficients are in close agreement over the temperature range from 100°F to 600°F, giving confidence in the calculational technique. The measured coefficient is slightly more negative than predicted over this temperature range, indicating that the predicted results are conservative which is a satisfactory situation in predicting the temperature coefficient. The results obtained on both heating and cooling cycles fit the same curve including the results obtained while the temperature was changing as well as those from equilibrium situations. There appears to be no significant effect due to loss of moisture from the fuel elements within the 8% uncertainty in the determination of reactivity difference over this temperature range. The data obtained at temperatures below 600°F after the core had been at 600°F for a considerable time fit the data obtained on the initial rise to 600°F. It also appears that temperature variations throughout the core and reflector were small. The isothermal condition is in part due to the slow heating and cooling rates. (auth)

12137 (GAMD-7359) ZERO POWER NOISE ANALYSIS AND ROD SCRAM TRANSIENT MEASUREMENTS IN PEACH BOTTOM: RESULTS OF POST CONSTRUCTION R AND D TEST PROCEDURES BP-19 AND BP-16. Brown, J.; Lane, R.; Merrill, M.; Mowry, W. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Oct. 1, 1966. Contract AT(04-3)-314. 25p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Noise analysis and rod scram transient zero power tests were carried out on Peach Bottom as base-line measurements for similar tests at power. From the noise analysis, there appears to be no resonant frequency from 0.1 to 100 cps which affects the core reactivity at low power from zero to full flow conditions. The rod-scram transient test shows that the method of analysis can be applied at power. The RODROP code for solving the equation for reactivity for a rod drop is discussed. (D.L.C.)

12138 (GEAP-4448) CONTROL ROD OSCILLATION AND TRANSIENT PRESSURE TESTS: BIG ROCK POINT BOILING WATER REACTOR. Hodde, J. A. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). July 1966. Contract AT(04-3)-361. 217p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An extensive series of control rod oscillation and pressure transient tests was performed over a wide variety of test conditions. The scope of testing, test descriptions, and equipment used in the tests are discussed and the test results are presented in the form of transfer function plots, transient traces, and tabular data. Pretest predictions of closed-loop transfer functions are also presented and discussed. The tests indicated that the Big Rock Point reactor core is stable and well regulated. (H.D.R.)

12139 (GEAP-4787) ANALYSIS OF FAST REACTOR TRANSIENT RESPONSE AND SAFETY IN SELECTED ACCIDENTS. Sherer, D. G.; Meinhardt, W. G. (General Electric Co., San Jose, Calif. Advanced Products Operation). June 1966. Contract AT(04-3)-189. 78p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

In the development of large fast reactors, attainment of the optimum balance between safety and economic considerations is one of the most important problems to be resolved. Conceptual designs have been developed. The Doppler coefficient is the primary means by which the time available before core damage can be increased in a reactivity insertion accident and the capability for absorbing accidental reactivity insertions improved. It is therefore a principal factor in determining requirements for control system performance, and in determining the consequences of a control system malfunction. The negative radii core expansion coefficient is the dominant factor in mitigating a loss of flow accident. It appears to be easier to design high negative radial expansion coefficients into highly pancaked cores than into cores of the same size and power density but with higher L/D ratios. The reactivity effects of sodium thermal expansion can be made small enough to be of little importance in reactor safety. Under the assumption that a scram does not terminate a reactivity insertion accident, failures are most rapid and occur in the most undesirable pattern in the core at the highest operating temperatures. During a loss-of-flow accident without scram, it may be possible, in all the cores studied, to suppress coolant boiling and cladding burnout, but fuel failure due to weakened cladding at elevated temperatures is likely. Among the factors to be considered in establishing a desirable radial power profile in the core is the pattern of failure and sodium voiding that will result if a sufficiently severe accident is postulated. It may be desirable, from a safety standpoint, to maintain some coolant flow during refueling. Because of the large number of assumptions that must be made in making a study involving failure mechanisms, core designs, and postulated accidents, the results are preliminary, but serve to focus further development of analytical methods as well as transient and burnout tests. (auth)

12140 (GEAP-4922) BISYN: A TWO DIMENSIONAL SYNTHESIS PROGRAM. Greebler, P.; Kelley, M. D.; Davis, R. A.; Keck, C. A.; Duncan, W. A. (General Electric Co., San Jose, Calif. Advanced Products Operation). July 15, 1965. Contract AT(04-3)-189. 150p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A two-dimensional diffusion program (BISYN) for core analysis of fast reactors is described in which the two-dimensional fluxes and adjoints are synthesized from one-dimensional solutions using a noniterative technique. (D.C.W.)

12141 (GEAP-4932) NUCLEAR SUPERHEAT PROJECT TWENTY-FOURTH QUARTERLY REPORT, MAY-JULY 1965. Ongman, H. D. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Aug. 1965. Contract AT(04-3)-189. 73p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Tensile property measurements at 1100 and 1300°F are given for the following alloys which were irradiated at 1300°F: Incoloy-800, 801, and 825; Inconel 625; and Fe-Cr-Al-Y. Tensile data are given for Incoloy-800 coupons of different sizes and shapes. Results are given of creep-rupture tests on biaxially stressed Incoloy-800. Stress-rupture tests were also conducted on Incoloy-800, Inconel-600, and Inconel-625, and the data are reported. The sintering characteristics of UO_2-Eu_2O_3 powder blends were determined. Work on the development of a melting technique for removing boron from Incoloy-800 is described. Corrosion data in steam are given for the following alloys: Incoloy-800, -801, and -804; Inconel-625 and -718; Hastelloy F; René-62; and type 310 stainless steel. Boundary layer turbulence promoters are being tested in a parallel rod array. Some measurements and reactivity data from the Mixed Spectrum Superheat Critical Experiment are reported. (D.L.C.)

12142 (GEAP-5087) NUCLEAR SUPERHEAT PROJECT. Final Report. Ongman, H. D. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Dec. 1965. Contract AT(04-3)-189. 104p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

All published results of the program are presented. The titles and publication numbers of all reports are presented together with a summary of information contained in each report. Information is included on program planning and coordination, materials development, coolant chemistry, heat transfer testing, and measurements made in the Mixed Spectrum Superheat Critical Experiment. (J.R.D.)

12143 (GEAP-5092(Vol.2)) SEFOR EXPERIMENTAL PROGRAM PLANNING. VOLUME II. DESCRIPTIONS OF PLANNED TESTS. Pflasterer, G. R. Jr.; Caldarola, L. (General Electric Co., San Jose, Calif. Advanced Products Operation). Aug. 1965. Contract AT(04-3)-540. 116p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The various planned tests for the Southwest Experimental Fast Oxide Reactor (SEFOR) are described and analyzed to provide a basis for the specification of the test program requirements and test equipment. The planned tests are described under the categories: critical tests, static tests, conventional frequency response tests, balanced frequency response tests, sub-prompt critical transients, and super-prompt critical transients. (H.D.R.)

12144 (NAA-SR-12242) HIGH HEAT FLUX HEATER DEVELOPMENT PRELIMINARY PERFORMANCE TESTS. Hayward, B. R.; Babbe, E. L.; Darley, D. K. (Atomics International, Canoga Park, Calif.). Dec. 31, 1966. Contract AT(11-1)-Gen-8. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Surface heat fluxes exceeding 1.0×10^6 Btu/ft^2-hr are operational requirements for advanced nuclear reactor fuel elements. An electrically heated power source has been developed that simulates these nuclear fuel elements in both radial dimensions and power density. The heater element consists of a resistance heated graphite core, $\sim 1/8$ in. diameter and 2 in. long, contained in a boron nitride electrical insulator and sheathed in stainless steel. Several of these heaters have operated in a dynamic Na loop at surface heat fluxes of $>1.5 \times 10^6$ Btu/ft^2-hr for over 400 hr. The design, fabrication, and test results of these heaters are described. Future advances in these nuclear fuel element simulators are outlined. (auth)

12145 (GEAP–5201) PRESTRESSED CONCRETE PRESSURE VESSEL FOR BOILING WATER REACTORS, 1000 MWe BWR REFERENCE DESIGN STUDY. Clabaugh, W. J. (comp.) (General Electric Co., San Jose, Calif. Advanced Products Operation). July 1966. Contract AT(04-3)-189. 89p. (EURAEC–1718). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The design of a boiling water reactor system for service in a cylindrical prestressed concrete pressure vessel is described. The reactor has a nominal 1000 MW(e) power rating and operates at 1000 psig. It features free surface steam separation and feedwater driven jet pumps for recirculation of the coolant flow. A summary is presented of the conceptual design studies performed to determine the most suitable BWR concept to proceed within the reference design study. Designs investigated were: natural and forced circulation; free surface and mechanical steam separation; cylindrical and spherical vessel internal shapes; and a range of core parameters. A summary report of the thermal insulation development is also presented. (auth)

12146 (IDO–12055) A METEOROLOGICAL STUDY OF CONTAINMENT VESSEL TEMPERATURES ON AN OPERATING REACTOR. Richter, Alden P. (Environmental Science Services Administration, Idaho Falls, Idaho. Air Resources Field Research Office). Sept. 1966. 15p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The containment vessel of an operating reactor (Experimental Breeder Reactor II) at the National Reactor Testing Station was instrumented with copper-constantan thermocouples to obtain temperature data. These data were correlated with ambient air temperatures and other meteorological variables. The mean ΔT (containment vessel skin-ambient air) curve plotted versus ambient air temperature range exhibits a slope of −0.20. Film stripping proved to be most directly related to atmospheric stability though normally of small magnitude. Temperature gradients are normally directed outward from the containment vessel. Diurnal temperature patterns reveal that the containment vessel behaves somewhat like a black body, absorbing insolation in the daytime and radiating energy to the atmosphere at night. Temperature patterns on the containment vessel are quite complex, especially during the daylight hours, being influenced by cloudiness, winds, atmospheric temperature gradients, and the sun angle. To date, during subzero temperatures, the reactor building as a heat source transfers heat to the atmosphere. This transfer rate maintains containment vessel temperatures well above those of the ambient air. These data represent transient periods of a few hours and may not be representative of lengthy subzero regimes. (auth)

12147 (NYO–3250-6) MOISTURE SEPARATOR STUDY. Rivers, Richard D.; Trinkle, John L. (American Air Filter Co., Inc., Louisville, Ky. Clean Air Group Research Lab.). June 1966. Contract AT(30-1)-3250. 56p. Dep. mn. CFSTI $3.00 cy, $0.50 mn.

For Connecticut Yankee Atomic Power Co., Haddam.

In the event of an incident at the Connecticut Yankee Atomic Power Plant, water sprays will be activated inside the reactor containment. Four recirculating filter systems of 40,000 cfm capacity each will be activated to reduce the concentration of radioiodine, its compounds and other fission products. These systems include charcoal filters (for removal of gaseous fission products) which are protected by high-efficiency particulate filters. Water droplets must not be allowed to reach these particulate filters, for water will block the filter media, causing a reduction in air flow and possible media rupture. A moisture separator to remove water droplets must be provided upstream of the particulate filter. Tests carried out on a proposed moisture separator to demonstrate its ability to remove water droplets under actual conditions of the assumed reactor incident are described. The test facility used was capable of circulating 1000 cfm of saturated air-steam mixtures at pressures up to 40 psi and 261°F., the maximum predicted conditions. Water sprays simulated the droplet cloud expected. The moisture separator removed essentially all droplets from the air stream under six test conditions with pressures ranging from 10 to 40 psi. High efficiency particulate filters downstream of the separator withstood test periods up to 24 hours at predicted maximum conditions without measurable loss of performance. (auth)

12148 (NYO–3266-1) MALIBU NUCLEAR PLANT UNIT NO. 1 PRELIMINARY HAZARDS SUMMARY REPORT. (Department of Water and Power, Los Angeles, Calif.). May 31, 1965. Contract AT(30-1)-3266. 454p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Factors considered in evaluating the safety of the proposed Malibu Nuclear Plant are presented. Preliminary design and safety features described in separate sections are: site, containment, reactor design, nuclear steam supply systems, shielding, instrumentation and controls, secondary systems, tests and operating procedures, administration and training, and accidents and potential hazards. (H.D.R.)

12149 (ORNL–4040) REMOVAL OF RADIOACTIVE METHYL IODIDE FROM STEAM–AIR SYSTEMS. Adams, R. E.; Ackley, R. D.; Browning, W. E. Jr. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 26p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

When fission-product I_2 is accidentally released into the air of a containment vessel, a generally small but often significant proportion of the iodine may exist as CH_3I. CH_3I readily penetrates beds of the usual types of charcoal unless the relative humidity is low. Recently, certain specially impregnated (iodized) charcoals have been observed to have the capability of effectively trapping radioactive CH_3I, by an isotopic exchange mechanism, from air streams of fairly high relative humidity at temperatures as high as 115°F. In the event of a nuclear reactor accident, however, the CH_3I trapping problem may be complicated by the production of steam with attendant elevation of the air temperature. Removal of radioactive CH_3I from flowing steam-air by impregnated charcoals has been investigated in two series of tests. Temperatures and pressures for one series were around 212°F and 14.4 psia, and, for the other series, generally around 280°F and 60 psia. According to the results obtained, $CH_3{}^{131}I$ can still be trapped effectively at these higher temperatures and, also, at the higher pressures by an appropriately selected impregnated charcoal provided the charcoal has not been damaged and provided the prevailing relative humidity in the charcoal does not exceed 90%. One of the impregnated charcoals was also tested to determine its capability for trapping elemental $^{131}I_2$. On the basis of a limited amount of data, this charcoal appears also to be very satisfactory for this purpose. (auth)

12150 (ORNL–4053) FISSION-GAS RELEASE AND IRRADIATION DAMAGE TO AVR PYROLYTIC-CARBON COATED THORIUM–URANIUM CARBIDE PARTICLES. Reagan, P. E. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 19p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Pyrolytic C-coated Th-U carbide particles, prepared commercially for use in the German AVR, were irradiated to 10 at. % heavy metal burnup at 1300°C in the ORR. These particles were a blend of several batches of duplex coated particles that were selected as representative of the coated particles to be used in the first AVR fuel loading. The fractional fission-gas release for ^{85}Kr was 5×10^{-6} at the beginning of the test and increased with burnup to 4×10^{-5}. No bursts of fission gas were released during the test and no broken coatings were found on postirradiation examination. Metallographic examination revealed some damage to the inner coating, but nothing that indicated potential failure of the coated particles. (auth)

12151 (ORNL-NSIC–13) FILTERS, SORBENTS, AND AIR CLEANING SYSTEMS AS ENGINEERED SAFEGUARDS IN NUCLEAR INSTALLATIONS. Keilholtz, G. W. (Oak Ridge National Lab., Tenn.). Oct. 1966. Contract W-7405-eng-26. 145p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Gas cleaning methods used at nuclear reactor plants and other places where radioactive substances must be removed from air before it is released to the atmosphere are presented. Pertinent information about the physical and chemical properties of fission products as they relate to trapping is given. Recent advances in the trapping (filtration and sorption) of radiation emitters are indicated. High-efficiency particulate air filters, sorbents, and air cleaning systems are described, and their uses as engineered safeguards for trapping radioactive aerosols and gases generated in nuclear installations are evaluated. (auth)

12152 (ORNL-TM–1729) EXACT SOLUTION TO THE FINITE-DIFFERENCE APPROXIMATION TO THE MULTIGROUP DIFFUSION EQUATIONS FOR A ONE-REGION SLAB REACTOR. Tobias, Melvin (Oak Ridge National Lab., Tenn.). Dec. 14, 1966. Contract W-7405-eng-26. 15p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The finite-difference approximation to the multigroup-diffusion equations for a one-region slab reactor in one, two, or three dimensions can be solved exactly for flux distribution and multiplication constant with relative ease, provided that the mesh spacing is uniform in each dimension. The results of such a calculation can provide a useful check upon the accuracy of finite-difference diffusion codes. The close analogy to the differential equation solution is shown. In particular, the flux distributions are shown to be the same simple cosine functions; the flux ratios between groups and the multiplication constant approach the differential equation results as the number of mesh points is increased. Any fission spectrum or group-to-group scattering matrix can be used. (auth)

12153 (PRWRA-101) BONUS PLANT CONVENTIONAL CYCLE HEAT BALANCE. Velez, Gilberto A.; Bonnet, Juan A. Jr. (Puerto Rico Water Resources Authority, San Juan). July 1966. Contract AT(40-1)-2672. 27p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A performance test was conducted on the conventional cycle of the Boiling Nuclear Superheater Station. The gross turbine heat rate corresponds to 10,500 Btu/kwh with an overall cycle efficiency of 32.8%. If the predicted net turbine heat rate was expected to be 10,458 Btu/kwh based on all feed water heaters in service, the turbine heat rate based on gross generator output would be 9,747 Btu/kwh. The corresponding deviation from the expected performance is 753 Btu/kwh, although this comparison is based on two slightly different loads and different conditions. (auth)

12154 (PRWRA-GNEC-5(Rev.)) BOILING NUCLEAR SUPERHEATER (BONUS) POWER STATION. Final Hazards Summary Report. (Combustion Engineering, Inc., Windsor, Conn. Puerto Rico Water Resources Authority, San Juan). Feb. 1, 1962. Revised Nov. 15, 1965. Contracts AT(40-1)-2674; AT(40-1)-2672. 712p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Important design and operational features of the BONUS Power Station which have an effect on the safety aspects of the station are summarized and evaluated. Treated in separate sections are: reactor plant design, power plant design, station operating procedure, reactor experiments, safeguards evaluation, radiological hazards from the maximum credible accident, siting, and plant organization. (H.D.R.)

12155 (TID-23510) GARIGLIANO NUCLEAR POWER PLANT. Operation Report for the 3rd Quarter of 1966. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). Sept. 30, 1966. 16p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Operating statistics, core performance, plant chemistry, and health physics activities are described for the Garigliano Power Reactor. (H.D.R.)

12156 (WAPD-MRP-118) PRESSURIZED WATER REACTOR (PWR) PROJECT. Technical Progress Report, July 23-October 21, 1966. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Contract AT(11-1)-Gen-14. 115p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A steam generator tube leak required shutdown of the B loop during Core 2 Seed 1 tests. The leak was from a single tube and located at about the mid-point of the tube U-bend. Fuel element swing load test plates are continuing to operate satisfactorily in the X-3 loop; they have been irradiated for 154 EFPD since completion of the swing load test. Modified compartmented oxide (MCO) plates have exceeded burnups of 80×10^{20} F/cc of compartment. Two MCO plates of similar fuel materials (non-angular aggregates) and with similar fission depletion levels ($70\text{-}80 \times 10^{20}$ F/cc), but different clad thickness, exhibited swelling of up to 13 mils Δt for the 0.029 in.-thick cladding and up to 27 mils Δt for the 0.020 in.-thick cladding. Irradiation of PWR Core 2 Seed 2 type fuel plates is continuing to very high burnups in the MTR VH-3 and ETR M-13 loops. One thin-clad PWR Core 2 blanket specimen (BOHR) failed during irradiation in the NRX reactor X-3 loop. The burnup and heat flux levels (13×10^{20} F/cc) of this failed plate were lower than those of normally clad specimens. Destructive examination of a PWR-2 blanket type, normally clad 90% TD UO_2 plate (COL11) which failed in the X-3 loop revealed fission gas releases of 5.3 to 7.6% (for a burnup level of 20×10^{20} F/cc) and H_2 levels in the cladding over non-failed compartments of 39-59 ppM H. An evaluation of the ^{235}U depletion and ^{10}B depletion of the special test assembly SOAP-II irradiated during Core 1 Seed 4 operation indicates that current calculational methods adequately predict the relative B-to-fuel depletion. (J.R.D.)

12157 (WAPD-TM-646) DETERMINATION OF CHEMICAL CONCENTRATION AS A FUNCTION OF TIME IN A TWO-VOLUME REACTOR COOLANT SYSTEM. Beal, S. K.; Henderson, D. R. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Nov. 1966. Contract AT(11-1)-Gen-14. 10p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Various chemical processes used in nuclear reactor plants require accurate knowledge of the time behavior of chemical concentrations within the reactor plant. A pressurized water reactor plant is considered to consist of two distinct volumes; one being the pressurizer, and the other being the reactor vessel and loop piping. Flow occurs between these two volumes and the concentration of a chemical solution introduced into one volume may lead or lag the concentration in the other volume, depending upon the relative volumes and flow rates. The differential equations which describe the time behavior of chemical concentrations, both in the pressurizer and the remainder of the primary plant, are solved for three different piping configurations. (auth)

12158 (WCAP-3269-18) LARGE CLOSED-CYCLE WATER REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Progress Report, April 1-June 30, 1966. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Contract AT(30-1)-3269. 28p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Results of research on corrosion of Zircaloy cladding in pressurized water is reported. Data on oxide thickness and orientation in corrosion layers on Zircaloy-4 are included. The status of experiments directed toward proof testing advanced fuel assembly prototypes is reported. Results of experiments on radioinduced swelling in clad UO_2 fuels are discussed. Developmental work on rod control cluster canless fuel elements is described and results of testing these elements are included. (JRD)

12159 STUDIES TO FURTHER ENERGY ECONOMY. Energ. Atomtech., 19: 153-6(Apr.-May 1966). (In Hungarian).

Present status and trends of small heat-producing nuclear plants are discussed and effects of peak-load factor on the economy of nuclear power plants are analyzed. (R.V.J.)

12160 RADIATION SITUATION NEAR NOVO-VORONEZH NUCLEAR POWER STATION. Petrosyants, A. M. At. Energ. (USSR), 21: 492-6(Dec. 1966). (In Russian).

Safety precautions and control of radioactive gases and aerosols and treatment of wastes from the 210,000 kW Novo-Voronezh nuclear power plant, with one VV-type reactor, are discussed. The power plant was put into operation in 1964 and had produced 2,165,000,000 kW hours by September 25, 1966. The power plant is equipped with a 120m stack with gas filters for short life isotopes and with special coffers for storing waste. Tabulated data are given on the density of radioactive fallout (10^{-3}c/km^2-day) measured by sedimentation method and radioactive content in air, soil, plants and Don River bottom measured in 1964, 1965, and 1966. (R.V.J.)

12161 SENA: BELGIUM-FRENCH NUCLEAR POWER PLANT. Atomwirtschaft, 11: 444-6(Aug.-Sept. 1966). (In German).

The characteristics of the SENA pressurized water advanced reactor are briefly summarized. The reactor control system and turbogenerators are also considered. (J.S.R.)

12162 REACTOR PRESSURE VESSEL FOR THE LINGEN NUCLEAR POWER STATION. Ullrich, W. (Allgemeinen Elektricitaets-Gesellschaft, Frankfurt am Main). Kerntechnik, 8: 464-70(Oct. 1966). (In German).

Calculation, design, and construction of the pressure vessel are discussed. Details of vessel design and the strains caused by gamma-heating and cycling during reactor transients are evaluated. The materials and the fabricating procedures are examined. The embrittlement of the material caused by fast neutrons and its effect on the pressure vessel safety is discussed. (auth)

12163 PRESSURIZED-WATER REACTORS IN BLOCK CONSTRUCTION. Junkermann, W. (Deutsche Babcock and Wilcox-Dampfkessel-Werke AG, Oberhausen, Ger.). Kerntechnik, 8: 458-63(Oct. 1966). (In German).

Pressurized water reactors in integrated construction termed block system with cylindric pressure vessel present a simple and relatively cheap nuclear steam system, which also requires a specially low energy for circulation of the cooling water. Using small-volume steam generators and in the combination with vapor suppression system in the safety containment the overall dimensions of the plant will become very small. With regard to the present status of technology, plants up to an electrical output of about 600 MW can be constructed as such a system. Reactor plants with the highest output feasible for ships may be transported to the site after being assembled completely in the workshop. (auth)

12164 AVR ATOMIC RESEARCH POWER PLANT. Cautius, Werner (Deutsche Braunkohlen-Industrie-Vereins, Duesseldorf). Braunkohle, 18: 125-32(Apr. 1966). (In German).

Pebble bed AVR Reactor is described. The operation, fuel element cooling circuit, gas purification, membrane compressors, pressure maintenance, reactor control, and safety are briefly considered. The research to be done with the high temperature reactor is briefly indicated. (J.S.R.)

12165 WELDING OF BOILER ELEMENTS FOR NUCLEAR POWER STATIONS. PART I. Roebuck, A.; Hargreaves, L. (Clarke Chapman and Co., Gateshead, Eng.). Weld. Metal Fabr., 35: 11-17(Jan. 1967).

The fabrication procedure for the Bradwell boiler elements is described. The original method of manual oxy-acetylene welding requiring a very high standard of technique was progressively replaced by automatic flash welding. A detailed account is given of the operation of the machine, and of the associated mechanised handling system. Experience gained in the welding of elements for the Latina station is reported. (UK)

12166 WELDING OF BOILER ELEMENTS FOR NUCLEAR POWER STATIONS. PART II. Roebuck, A.; Hargreaves, L. (Clarke Chapman and Co., Gateshead, Eng.). Weld. Metal Fabr., 35: 67-70(Feb. 1967).

For Dungeness 'A' power station separate elements of a four-flow type were manufactured by flash welding of 27-ton electrically resistance-welded finned tubing. The spacers were spot welded. Elements were built up into boiler units at the works for the Oldbury station using 20-ton tubing. Details of the handling procedure, changed from vertical to horizontal, and of the fabrication are given. Following experience of internal cracking in the heat-affected zone in 27-ton tubing, it was found necessary to use argon-arc welding for this material. Research and development are reviewed. (UK)

12167 SELF-SUSTAINED HYDRODYNAMIC OSCILLATIONS IN A NATURAL-CIRCULATION BOILING WATER LOOP. Jain, K. C. (Northwestern Univ., Evanston, Ill. Argonne National Lab., Ill.); Petrick, M.; Miller, D.; Bankoff, S. G. Nucl. Eng. Design, 4: 233-52(Oct. 1966).

Measurements are given of flow and pressure oscillations over a range of steady power inputs to a natural-circulation boiling water loop for several riser and test section geometries and at 200 to 1000 psia. In some cases the inception threshold is sharp, but in others the oscillations grow monotonically. The effects of system parameters are discussed, and the results are compared with existing theory. (auth)

12168 HEAT TRANSFER CALCULATIONS OF ORGANIC COOLED SEVEN-ROD CLUSTER FUEL ELEMENTS. Nijsing, R.; Eifler, W. (Joint Nuclear Research Center, Ispra, Italy). Nucl. Eng. Design, 4: 253-75(Oct. 1966).

A description is given of calculation methods employed to establish the thermal performance of 7-rod-cluster fuel elements. In evaluating the effects of asymmetric neutron flux distribution and flux peaking account was taken of conduction in fuel and cladding. Consideration is given to the process of coolant mixing between subchannels. The calculation procedure, which has been programmed for the IBM 7090 computer, enables the fuel element power to be calculated when the maximum allowable values of outlet coolant temperature and of the cladding temperature are specified and when input information is given concerning dimensions, fluid flow, and heat transfer. Numerical examples are discussed. (auth)

12169 EXPERIENCE FROM THE CONSTRUCTION OF REACTOR CONTAINMENTS. Ullrich, W. (Allgemeine Elektrizitaetsgesellschaft, Frankfurt am Main). Kerntechnik, 8: 380-7 (Aug.-Sept. 1966). (In German).

Methods for the construction of containment vessels applied in the U.S.A are discussed. The experience from the fabrication of four containers (VAK Kahl, KRB Gundremmingen, KWL Lingen and HDR Groswelzheim) in respect to design, calculation, construction material, and welding is outlined. The difficulties encountered are analyzed. The experience described forms a good basis for the safe erection of similar containers in the future. (auth)

12170 INCREASED PROTECTION OF THE ENVIRONMENT OF NUCLEAR PLANTS BY DOUBLE CONTAINMENTS. Tietze, A. (Technische Ueberwachungs-Vereine, Cologne). Kerntechnik, 8: 387-91(Aug.-Sept. 1966). (In German).

The environment of a nuclear plant is protected to a higher degree when a double containment is provided. This increase in safety is due to several effects of the gap between the two containers on the radioactive gases escaping from the inner enclosure. Three double containments with different properties are compared, and their effects are discussed. The results show that an increase in safety is achieved only by a properly designed double container. (auth)

12171 ON THE TECHNOLOGICAL STATUS OF REACTOR PRESSURE-VESSELS, ESPECIALLY THOSE OF PRE-STRESSED CONCRETE. Koepcke, W. (Technische Univ., Berlin). Kerntechnik, 8: 391-6(Aug.-Sept. 1966). (In German).

The size of steel pressure-vessels is limited by production possibilities. Reactor containers of pre-stressed concrete, on the contrary, can be made in nearly every shape and size; so they are especially qualified for large nuclear plants in integrated construction. The concrete containers which have been built, are under construction, or are designed are described and shown in sectional drawings. Particular problems associated with the construction of pre-stressed concrete containers are analyzed. Technology is developed far enough that security requirements can be fulfilled. (auth)

12172 THE REACTOR PRESSURE-VESSEL FOR THE NUCLEAR RESEARCH SHIP "OTTO HAHN." Meinhardt, G.; Weber, D. (Deutsche Babcock and Wilcox-Dampfkessel-Werke AG, Oberhausen, Ger.). Kerntechnik, 8: 396-401(Aug.-Sept. 1966). (In German).

The fabrication of the pressure vessels for the nuclear research ship Otto Hahn is discussed. A discussion of the construction and the characteristic calculation conditions, with special regard to the ship-building requirements, is presented. The fine-grained structural steel (15 MnMoNiV 53) used for the forged construction has high-temperature strength and good impact resistance. During the fabrication of the vessel, particular attention was directed to welding, plating, and cutting work. The smaller nozzles were welded by a new procedure in form of a ferrite outer plating. High-quality machine tools were used to satisfy the required tolerances. (auth)

12173 SAFETY REQUIREMENTS FULFILLED IN THE STEAM GENERATOR FOR THE AVR NUCLEAR POWER STATION. Johannknecht, N. (Vereinigte Kesselwerke AG, Dusseldorf). Kerntechnik, 8: 402-4(Aug.-Sept. 1966). (In German).

During the construction of heat-exchangers and associated equipment for nuclear reactor plants careful attention must be paid to safety requirements. A survey of the points to be considered when designing and constructing the walls of the heating surfaces which are in direct contact with the reactor cooling gas is given under reference to the terminated steam generator for the AVR nuclear power station. The development and construction of a new type heat exchanger are described and features and safety provisions examined. The steam generator is designed and constructed to meet maximum safety requirements, and the demand for higher safety than is usual with conventional plant is complied with by a variety of tests. Concluding the problems involved with wet laying-off are discussed which method is used to keep available the entire tube system. (auth)

12174 AUTOMATIC CONTROL OF NUCLEAR REACTORS. Marcillat, G. (EURATOM, Ispra, Italy). Onde Elec., 46: 1237-43(Nov. 1966). (In French).

After a review of the dynamic properties of the nuclear reactors, and of the constraints in the neutron power evolutions, a control method is derived, which is valid without modification or commutation for both stationary and dynamical states. With the aid of a specific case it is shown that a simple system can realize an automatic control with good performance. An analog simulation of the plant and control system is used to demonstrate the validity of the various assumptions and simplifications. (auth)

12175 A PROGRAM FOR COMPUTATION OF THICK PRESSURE VESSELS BASED ON DYNAMIC RELAXATION. Tarandi, T. (Aktiebolaget Atomenergi, Stockholm). Nucl. Eng. Design, 4: 329-30(Oct. 1966).

A computer program is described for calculation of reactor pressure vessel parameters with thickness–diameter ratios of one half or more as required for light or heavy water-cooled reactors. A dynamic relaxation method is used in the calculation. The program is applicable to cylindrical pressure vessels with plane heads. (J.R.D.)

12176 CALCULATION OF MAXIMUM EQUILIBRIUM PRESSURE AND TEMPERATURE INSIDE THE CONTAINMENT OF A PRESSURIZED WATER REACTOR FOLLOWING RUPTURE OF THE PRIMARY COOLANT CIRCUIT. Galli, R. B.; Lord, B. G. (Suiselectra, Basel). Nucl. Eng. Design, 4: 331-8(Oct. 1966).

A review is made of simple methods available for calculating the initial maximum equilibrium pressure and temperature occurring inside the containment of a pressurized water reactor plant following the rupture of part of the primary coolant circuit. The flashing to steam of the primary coolant through the rupture is considered as a constant internal energy expansion process. Using the parameters of a typical 700 MWe pressurized water reactor, the equilibrium pressure and temperature are calculated as a function of the containment volume. (auth)

12177 INSERTION IN HEAVY-WATER REACTORS OF DEPLETED URANIUM FOR UTILIZATION. Gruemm, H. (SGAE, Vienna). Nukleonik, 8: 446-8(Nov. 1966). (In German).

If heavy-water reactors, which operate on slightly enriched uranium (0.8 to 1.2%), are loaded with depleted uranium from the reprocessing of fuel from light-water reactors, the use of separation installations is reduced. In addition, with such a "consumption cascade" transport and conversion costs could be saved. (tr-auth)

12178 INFLUENCE OF THE DISINTEGRATION OF OXIDE FUELS ON THE COURSE OF POWER EXCURSIONS IN FAST REACTORS, WHICH WILL BE INTERCEPTED BY THE DOPPLER COEFFICIENT. Fischer, Erhard A.; Keller, Karl (Kernforschungszentrum, Karlsruhe, Ger.). Nukleonik, 8: 471-80 (Nov. 1966). (In German).

The heterogeneity of a nuclear fuel consisting of a mixed oxide, for example, PuO_2–UO_2, leads to a sharper power excursion, which

can be intercepted by the Doppler coefficient, in a reactor than in the case of an exactly homogeneous fuel. The conditions were investigated, using an analog calculator, for a typical fast breeder reactor assuming a schematically heterogeneous structure of the fuel. Allowable limits for the height and steepness of the reactivity disturbance are given, with melting of the Pu component of the fuel considered as a limiting condition. Accident analysis of a Na-cooled fast breeder reactor showed that a degree of heterogeneity of 75 μ is allowable. (tr-auth)

12179 SOLUTION OF REACTOR KINETICS EQUATIONS BY B.W.K. APPROXIMATION. Tan, Sevim (Middle East Technical Univ., Ankara). Nukleonik, 8: 480-3(Nov. 1966).

An explicit solution is given to reactor kinetics equations for arbitrarily varying reactivity insertions. Feedback effects are neglected and one average group of delayed neutrons is assumed. From the general equation, solutions for step, ramp and sinusoidal inputs are derived. Conditions for the validity of the solutions are found not to be strict. Results of the method are compared with the more accurate solutions obtained by digital techniques. The method finds an excellent field of application especially for sinusoidal reactivity variations. Approximations obtained for the cases considered are very good. Smaller neutron lifetime yields even better accuracy. (auth)

12180 FUEL-ELEMENT EXPERIENCE IN PRESSURIZED-WATER REACTORS. Ferrari, H. M.; Allio, R. J. (Westinghouse Electric Corp., Pittsburgh). Nucl. Appl., 2: 492-8(Dec. 1966).

Fuel-element performance in operating pressurized-water reactors has been excellent. Over 250,000 fuel elements containing UO_2, UO_2-ThO_2, or UO_2-PuO_2 fuel clad with Fe- or Zr-base alloys performed reliably over a broad range of operating conditions. Experimental evidence to date suggests that fuel elements for pressurized-water reactors can be subjected to more demanding conditions. (auth)

12181 EXAMINATION OF FUEL AND CLADDING IN PWR-1 BLANKET RODS. Rubin, B.; Lynam, L. (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Appl., 2: 499-504(Dec. 1966).

High-density UO_2 fuel pellets in blanket rods of the first Shippingport core show no structural change after depletions to 6.4×10^{20} fissions/cm^3. After 1885 days in hot water, corresponding to post-transition corrosion conditions, the Zircaloy-2 tubing shows a mottled appearance and an oxide thickness averaging 2.4 μm, predictable from out-of-pile autoclave testing. The hydrogen content of the tubing agrees reasonably well with similar predictions. (auth)

12182 CANDU FUEL PERFORMANCE IN NPD. Pawliw, J. (Canadian General Electric Co. Ltd., Peterborough, Ont.); Chalder, G. H.; Popple, R. T. Nucl. Appl., 2: 505-9(Dec. 1966).

Over 1500 fuel bundles were irradiated in NPD. Most of this fuel was sheathed with thin, collapsible sheathing. Burnups and residence times exceeded 10,000 MWd/t U and 850 days, respectively. The deuterium picked up by the Zircaloy-2 sheathing from the heavy-water coolant has not affected fuel performance. Dimensional changes varied from no change to $< 0.05\%$ and $\approx 0.5\%$ on element lengths and dia, respectively. Measured fission-gas release was $< 0.1\%$ of that generated. A defected bundle showed little or no deterioration after two and one-half years operation. For NPD, the first operating reactor of the CANDU-PHW type, the fuel performance was proved. (auth)

12183 FUEL PERFORMANCE IN BOILING-WATER REACTORS. Pashos, T. J.; Williamson, H. E.; Duncan, R. N. (General Electric Co., San Jose, Calif.). Nucl. Appl., 2: 510-14(Dec. 1966).

Since the initiation of fuel irradiations in the Vallecitos Boiling Water Reactor in 1957, rod-type fuel elements have been irradiated in an increasing number of boiling-water reactors. The most extensive experience was obtained with Zircaloy-2 clad, UO_2 pellet-type fuel rods. Somewhat less experience has been obtained with other fuel forms such as ThO_2-UO_2 pellets and UO_2 compacted powder and with other clad materials such as Zircaloy-4, Type 304 stainless steel, Incoloy-800, and Inconel-600. Based on the successful performance of many thousands of fuel segments operating at typical commercial power-reactor thermal ratings, UO_2 rods clad with Zircaloy-2 were found to be the most reliable and economical fuel elements for boiling-water reactor applications. (auth)

12184 PERTURBATIONS, MASS, AND CRITICAL MASS. Devooght, J. (Univ. Libre, Brussels). Nucl. Sci. Eng., 26: 385-92(Nov. 1966).

Rigorous transport relations between mass, critical mass, and arbitrary perturbations are developed for nonuniform reactors. It is shown that reactivity is equal to the difference between the fractional increase of mass and critical mass, multiplied by the fractional destruction rate of total importance by moderator or by leakage. Sufficient conditions for an increase or decrease of critical mass in nonuniform reactors are obtained, and it is shown that burnup always increases the critical mass of thermal reactors. (auth)

12185 REPLICATE FOR CHEAPER NUCLEAR POWER. Waine, P. (Fairey Engineering Ltd., Stockport, Eng.). New Sci., 33: 90-1(Jan. 12, 1967).

It is argued that by standardizing certain basic design considerations, reactors could be built appreciably cheaper, without jeopardizing the economics which may accrue from technical progress. (auth)

12186 COUPLED-REACTORS KINETICS EQUATIONS. Plaza, H.; Koehler, W. H. (Texas A and M Univ., College Station). Nucl. Sci. Eng., 26: 419-22(Nov. 1966).

The coupled-reactors kinetics equations are derived within the frame of neutron transport theory. The method consists of specifying the neutron population within a reactor by a single equation and classifying neutrons on the surface of the reactor by groups according to the direction in which they travel with respect to a unit normal at the surface. The concept of surface coupling is used to account for the neutronic interaction between the reactors. (H.D.R.)

12187 FUEL-CYCLE ANALYSIS OF MOLTEN-SALT BREEDER REACTORS. Bauman, Howard F.; Kasten, Paul R. (Oak Ridge National Lab., Tenn.). Nucl. Appl., 2: 287-93(Aug. 1966).

Thermal- and intermediate-energy molten-salt breeder reactors appear capable of fuel doubling times less than 20 years and fuel-cycle costs under 0.4 mill/KWhr. These reactors are fueled with circulating molten salts consisting of the fluorides of Th, U, Li, and Be. Three reactor concepts are analyzed; the first two are graphite-moderated thermal breeders. In the first of these, the fissile and fertile materials are separated by graphite tubes in the core; in the second, the fissile and fertile material are included in a single salt stream. In the third concept, an intermediate-energy breeder, the core is an unmoderated salt containing both fissile and fertile materials. The reactors are optimized for minimum fuel-cycle cost and maximum annual fuel yield. The results show that each concept is capable of a low fuel-cycle cost and a short doubling time; however, the major development problems are different for each concept. (auth)

12188 STABILITY EXTREMA IN NUCLEAR POWER SYSTEMS WITH DESIGN UNCERTAINTIES. Kerlin, T. W. (Oak Ridge National Lab., Tenn. Univ. of Tennessee, Knoxville). Nucl. Sci. Eng., 27: 120-30(Jan. 1967). (ORNL-P-2232).

A systematic procedure is presented for calculating the least stable condition in a reactor system that can occur within the uncertainty range on system parameters. This uncertainty range is due to the impossibility of perfectly predicting design parameters and the effect of aging of the system on these parameters. The method uses the linear approximation to the system dynamics equations and a steepest ascent extremum-seeking procedure. The procedure can also be reversed to determine design changes needed to give greater system stability. The applicability of the method for solving practical reactor problems has been demonstrated in an analysis of the Molten Salt Reactor Experiment using a computer program developed to implement the method. (auth)

12189 ACTIVATION OF CORROSION PRODUCTS IN NUCLEAR REACTORS. Veselkin, A. P.; Nikitin, A. V. At. Energ. (USSR), 21: 184-9(Sept. 1966). (In Russian).

Mass transfer and activation of corrosion products in pressurized-water and in boiling reactors were analyzed. A mathematical expression and solution of the mass-transfer equation for a stationary case, and an approximate solution of the non-stationary problem for ^{60}Co accumulation were constructed. The experimental data were analyzed on the basis of the obtained solutions and mean values of mass-transfer coefficients were obtained for several reactor systems: for the precipitation probability ($\omega = 3.5 \times 10^{-5}$ sec^{-1}) and washing of particles ($\gamma = 5 \times 10^{-8}$ sec^{-}). (tr-auth)

12190 NUCLEAR FUEL EFFICIENCY CRITERION. Batov, V. V.; Koryakin, Yu. I. At. Energ. (USSR), 21: 179-84(Sept. 1966). (In Russian).

The basis and criterion of nuclear fuel efficiency was evaluated considering a one-region thermal reactor with homogeneous initial fuel charge operating without partial reloading (the active zone was reloaded simultaneously when the fuel reached the mean depth of burn-up). (tr-auth)

12191 STABILITY ANALYSIS OF A SAMPLED-DATA CONTROLLED NUCLEAR REACTOR SYSTEM. Reisch, Frigyes

(Aktiebolaget Atomenergi, Stockholm). Nucl. Sci. Eng., 26: 378-84(Nov. 1966).

In a digital computer controlled system it is possible to monitor several variables almost at the same time and control the system according to the most critical one. This is called a sampled-data control system. A method for handling such a problem is presented. A simplified reactor system including neutron kinetics and fuel and cooling medium kinetics with a simple control circuit is examined. It is assumed that the reactor has a great number of cooling channels, and it is necessary to check the exit temperatures of the cooling medium as the maximum value is the limiting factor. Sampling is performed to accomplish this. The temperatures are scanned and a comparison is made between the value stored in the memory and the point being measured. The higher of the two values remains in the one word memory. After checking all the temperatures, a pulse representing the temperature of the hottest channel is sent through the sampler to the regulator and the memory is cleared. A suitable method to study the stability is the $\mathcal{Z}$ transform analysis. The procedures and logic followed are outlined. First, the system is defined in the terms of Laplace transformation. Then the solving of the sampled system problem by the $\mathcal{Z}$ transform theory is shown. A digital computer program is developed. The results of several calculations show the importance of choosing the right parameter combinations. (auth)

12192 MAXIMUM TEMPERATURES IN A FLAT-PLATE FUEL ELEMENT WITH FUEL-CLAD BONDING DEFECTS. Rowe, D. S. (Pacific Northwest Lab., Richland, Wash.); McFeron, D. E. Nucl. Sci. Eng., 26: 319-28(Nov. 1966). (BNWL-SA-600).

A mathematical model that describes the heat transfer in a defectively bonded flat-plate fuel element is presented. The bond defect is assumed to exist only on one side of the fuel plate and to be either a circular spot or infinite strip in shape. Details of the general solution to the heat conduction equation for the mathematical model are shown for the strip-type defect. For a particular type of defect, the temperature distribution is dependent upon three dimensionless parameters that include the effects of defect size and the heat transfer properties of the defective fuel element. Data are provided in terms of the three dimensionless parameters that permit rapid estimates of fuel temperatures in fuel plates with strip and spot defects. These defects are assumed to be step reductions in the normal fuel-boundary conductance. Defect sizes on the order of a couple of fuel thicknesses can cause significant local increases in the fuel temperature and fuel-surface heat flux. (auth)

12193 FLOW OF BOILING WATER IN HEATED PIPES. Shotkin, Louis M. (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 26: 293-304(Nov. 1966). (BNL-8884).

A spatial-averaged model of a boiling hydraulic channel is presented. Linearized analytical results are compared, with reasonably good agreement, with several transfer functions measured by Zivi, Wright et. al. in a boiling loop at atmospheric pressure using both natural and forced circulation. The necessity of applying a heat source correction to the experimental data is discussed, and the role that the dynamic pressure plays is presented. The physical mechanism causing the experimentally observed hydraulic instability is shown to be an interaction between the transient flow and friction pressure drop in the two-phase region. The experimentally observed increase in unstable oscillation frequency with inverse boiling length is also shown analytically. The position of the boiling boundary in the channel is shown to be important in stability considerations. By comparing analytical results with experimental data of Wissler et. al. and Becker et. al. it is concluded that the least-stable situation results when the boiling boundary is partway up the channel. Since the position of the boiling boundary is directly related to the degree of subcooling, the existence of this crucial position is used to explain the influence of subcooling on stability. (auth)

12194 CONSTRUCTION OF REACTOR FITTINGS: PROPOSALS OF DIENST VOOR HET STOOMWEZEN. van der Laken, R. A. Atoomenergie Haar Toepass., 8: 200-3(Sept. 1966). (In Dutch).

The requirements drafted by the Dienst voor het Stoomwezen for the design of reactor vessels are given. (tr-auth)

12195 GUNDREMMINGEN NUCLEAR POWER PLANT. Jaerschky, Rudolf (Allgemeine Elektrizitaetsgesellschaft, Frankfurt am Main). At. Strom, 12: 103-6(Sept.-Oct. 1966). (In German).

The construction of the Gundremmingen nuclear power plant is outlined. A cross section of the installation is given and the principal characteristics are tabulated. (J.S.R.)

12196 CONTROL AND INSTRUMENTATION OF THE GUNDREMMINGEN NUCLEAR POWER PLANT. Taurit, Rudolf (Allgemeine Elektrizitaetsgesellschaft, Frankfurt am Main). At. Strom, 12: 116-20(Sept.-Oct. 1966). (In German).

The control principle of the power plant is outlined. The scheme of the control rod drive is given and the reactor control principles are reported. The instrumentation for neutron flux monitoring, logarithmic and linear measurement channels, and core measurements is illustrated. The conventional reactor instrumentation is outlined. The radiation monitoring devices used are described. (J.S.R.)

12197 THE HIGH-VOLTAGE INSTALLATION OF THE GUNDREMMINGEN NUCLEAR POWER PLANT. Ignatowitz, Waldemar (Allgemeine Elektrizitaetsgesellschaft, Frankfurt am Main). At. Strom, 12: 121-4(Sept.-Oct. 1966). (In German).

The current production and distribution is described. The power needs of the power plant are outlined. The switch devices and automatic controls of the high-voltage installation are discussed. (J.S.R.)

12198 THE START-UP OF THE GUNDREMMINGEN NUCLEAR POWER PLANT. Staebler, Karl (Kernkraftwerk RWE-Bayerwerk GmbH, Gundremmingen, Ger.); von Zorkoczy, Andreas. At. Strom, 12: 127-32(Sept.-Oct. 1966). (In German).

The start-up procedure for the Gundremmingen nuclear power plant (including the pre-start-up tests, zero-power tests, power tests, and test operation) was outlined. (J.S.R.)

12199 CONSTRUCTION ENGINEERING VIEWPOINT IN THE PLANNING AND CONSTRUCTION OF THE GUNDREMMINGEN NUCLEAR POWER PLANT. Knobling, Karl-Heinz; Wangerin, Wolfgang (Allgemeine Elektrizitaetsgesellschaft, Frankfurt am Main). At. Strom, 12: 124-7(Sept.-Oct. 1966). (In German).

The effect of the construction engineering on the site selection, terrain choice, and arrangement of the plant is indicated. Special precautions with respect to radiation protection in the construction are discussed. (J.S.R.)

12200 THE PRINCIPAL HEAT CIRCUIT AND THE TURBINES IN THE GUNDREMMINGEN NUCLEAR POWER PLANT. Wetzel, Juergen; Roeger, Hans (Allgemeine Elektrizitaetsgesellschaft, Frankfurt am Main). At. Strom, 12: 113-16(Sept.-Oct. 1966). (In German).

A schematic diagram of the primary heat circuit is given and discussed. The turbine assembly is described. (J.S.R.)

12201 THE REACTOR OF THE GUNDREMMINGEN NUCLEAR POWER PLANT, ITS AUXILIARY SYSTEM AND SECONDARY PLANTS. Foreman, C. E.; Spierling, Herbert. At. Strom, 12: 107-12(Sept.-Oct. 1966). (In German).

The Gundremmingen reactor is a two-circuit boiling water reactor with three forced rotation loops. Slightly enriched UO_2 is used as fuel. The constituents of the reactor, its auxiliary system, and the secondary engineering plants are described. (J.S.R.)

12202 CANADIAN NUCLEAR POWER PROGRAM. Gray, J. L. Energ. Nucl. (Paris), 8: 460-4(Nov. 1966).

After a historical discussion of the first studies on building nuclear power stations in Canada, the main characteristics of the Douglas Point nuclear power station are given. The Pickering nuclear power station and the role played by the Atomic Energy of Canada Limited in the nuclear supplying of the country are then described. An outline of the projects and plans for the future are given. (auth)

12203 FABRICATION OF FORGED PRESSURE VESSELS. Nucl. Eng., 11: 869-70(Nov. 1966).

Boiling-water reactor pressure vessels are being manufactured by the Rotterdam Dry Dock Company for the Dodewaard 50-Mw(e) station and for the 440-Mw(e) Nuclenor reactor. Advantages of forging are enumerated and the design and fabrication methods are described. (UK)

12204 PRESSURE DROP OF NARROW ANNULAR CHANNELS WITH SPIRAL FINS. Subbotin, V. I.; Ushakov, P. A.; Sheinina, A. V. At. Energ. (USSR), 21: 13-16(July 1966). (In Russian).

The pressure loss in narrow ($d/D = 0.895$) circular channels with three fins, rolled in spirals on the central rod, was measured. In the region of comparative steps of fin windings of $3.5 < T/d < \infty$, the pressure loss in turbulent regime was determined for the basic loss in friction on the channel walls. This loss can be calculated by the usual formulas for circular channels without fins. The increase of the pressure drag of the channels during fixed input of the liquid becomes effective only at small comparative steps of fin windings ($T/d < 10$). The data obtained for circular channels approximately agree with the results of the measurement of the pressure drop in staggered bundles of finned rods with $S/d = 1.05$, with longitudinally streamlined heat carriers. (tr-auth)

12205 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Davidson, Jan (to United Kingdom Atomic Energy Authority). British Patent 1,039,588. Aug. 17, 1966. Filed Aug. 20, 1964.

A liquid moderated, liquid cooled reactor includes a pre-stressed concrete pressure vessel with an internal metal lining. The reactor core and the body of the liquid moderator/coolant are contained within the lining. However, the lining and the concrete pressure vessel are spaced somewhat apart and held in this manner with thermal insulation members composed of concrete encased in stainless steel and some of the liquid moderator/coolant is allowed to occupy the space between the lining and the vessel. This restricted communication between the two volumes of moderator/coolant largely restricts heat transfer by convection between the main body of moderator/coolant and that in the space. (B.L.M.)

12206 NUCLEAR REACTOR WITH FUEL HANDLING APPARATUS. Stacey, John; Riley, Peter Liptrot; Parker, Horace Frank (to United Kingdom Atomic Energy Authority). U. S. Patent 3,280,001. Oct. 18, 1966. Priority date June 25, 1963, Great Britain.

A design for a fast reactor includes a core made up of a thin cellular structure formed of parallel open end tubes to receive the fuel elements and with means to circulate the coolant upwardly through the tubes to extract the heat from the fuel. A support platform is disposed above the core with rigid struts dependent from the support platform. Means are provided at the lower end of the struts for establishing with the fuel units a connection to support the units in the tube. This connection is removable by remote operation at the upper end of the struts, and fuel handling apparatus to present the fuel units beneath the struts is connectable in its place. (B.L.M.)

12207 IMPROVED NUCLEAR REACTOR AND FUEL MANAGEMENT THEREFOR. (to General Dynamics Corp.). British Patent 1,050,608. Dec. 7, 1966. Priority date July 20, 1964, United States.

A Th–^{233}U breeder reactor is described that comprises a reactor core including nuclear fuel in segregated fuel units. A first group of fuel units contains the U and a second group contains the Th. To facilitate the fuel reprocessing, the fuel units of one group are coated with a protective coating that serves as a moderator, that is impervious to gaseous fission products, and that is chemically non-reactive with a substance in which the fuel units of the other group can be dissolved. A fuel management program for the breeder reactor is proposed that eliminates the buildup of heavy nuclide poisons, such as ^{236}U and ^{237}Np. After the reactor has been charged and operated for the desired reactivity life of a selected portion of the fuel units, these units are removed and reprocessed to remove the fission products and heavy nuclides, which along with Th and makeup enriched U are returned to the reactor for a subsequent reaction cycle. (B.L.M.)

12208 CONTROL ROD DRIVE. Takahashi, Jiro (to Meidensha Electric Mfg. Co., Ltd.). Japanese Patent 1966-3598. Mar. 2, 1966. Filed Mar. 25, 1963.

The control rod drive has simple construction. Shim and fine-adjustment of a single control rod and ease in fabrication and construction and high reliability are simplified. The long threaded rod for moving a control rod for both the shim and fine-adjustment controls engages with the two long nuts for the shim and fine-adjustment respectively. These two nuts are located up and down along the threaded rod. For the shim control, the upper nut moves together with the threaded rod; for the fine-adjustment the lower nut moves with the threaded rod. For the latter, provision is made for controlling the length of the up or down movement. The shim and the fine-adjustment rod movement are achieved by the respective mechanisms, including a worm-wheel, a worm, an electric motor, etc. (tr-auth)

12209 DEVICE FOR PRODUCING SIMULATED REACTOR SIGNALS. Okano, Yoshihiko (to Mitsubishi Atomic Power Industry, Inc.). Japanese Patent 1966-5999. Mar. 30, 1966. Filed Sept. 28, 1963.

Producing signals which simulate the electrical signals in reactor operation is the function of this device, which does not use radiation pulses. It is based on the fact that the pulse-height distribution of the noise pulses, occurring in the vicinity of the opposite-direction breakdown voltage of a semiconductor diode, possesses good index characteristics and the pulse intervals at each count-rate obey the Poisson distribution; and it consists of electric circuits alone. It produces irregular series of pulses varying in the count-rate accurately and in a wide range corresponding to the operating condition of a reactor. By means of the simulated signals, it is possible to test and adjust a reactor instrumentation control system and know its performance prior to its actual installation. The noise pulse signals, occurring in the vicinity of the opposite-direction breakdown voltage of a semiconductor diode, are taken out from the output side of the irregular noise-pulse generator, and the pulse-heights of the pulse signals are selected by means of the output voltage of a time-function generator, and the irregular series of pulses with the count-rates corresponding to the pulse-height selecting voltage is produced. Thus, the signals, simulating the electric signals in the reactor operation, are obtained. (tr-auth)

12210 10 JAHRE KERNFORSCHUNGSZENTRUM KARLSRUHE. (10 Years Nuclear Research Center Karlsruhe). Karlsruhe, Ger., Gesellschaft fuer Kernforschung mbH, 1966. 201p.

The scope of the work done at the Karlsruhe nuclear research center is described by a series of articles outlining its 10 years of operation. The areas discussed are the fast breeder project, the Karlsruhe Research Reactor FR2, the isochronous cyclotron, the school for nuclear technology, neutron and reactor physics studies, applications of reactor physics, studies on vapor cooling, work on nuclear data and general neutron physics, nuclear and elementary particle physics, investigations on the chemistry of the transuranic elements, contribution to the processing of nuclear fuel elements, preparative radiochemical substitution of aromatic compounds in solutions, material and solid body studies, quantitative radiobiology, medications against radioactive poisonings, and studies on reactor engineering. (J.S.R.)

12211 NUCLEAR RADIATION SHIELDS. Lakin, Raymond Wallis; Youell, Frederick Peter (to The Nuclear Power Plant Co. Ltd. A. E. I.-John Thompson Nuclear Energy Co. Ltd.). British Patent 1,054,219. Jan. 4, 1967. Filed Apr. 24, 1964.

A radiation shield design, primarily for reactor cores, is presented. Reactor core shielding must be capable of moderating fast neutrons, capturing thermal neutrons, and have sufficient density to attenuate gamma radiation originating from the core and from neutron capture. (D.C.W.)

Marine and Portable Power Reactors

12212 (BMI-X-10168) IRRADIATION OF HIGH-TEMPERATURE ACTUATOR ASSEMBLIES IN A VACUUM FOR THE SNAP-8 REACTOR SYSTEM. Basham, Sam J.; Zielenbach, William J.; Gruber, H. Thomas; Allgeier, Joseph P. Jr. (Battelle Memorial Inst., Columbus, Ohio). June 15, 1966. Contract W-7405-eng-92. 22p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Two actuator and position-sensor devices were irradiated to integrated fast-neutron exposures of 4 and 7×10^{18} n/cm^2 in a high-vacuum environment (4×10^{-6} torr) at temperatures of 800 to 1000°F to obtain radiation-effects data for the Atomics International SNAP-8 program. Detailed measurements of the nuclear environment were made to aid in the study of radiation damage to the specimens. Temperatures and vacuum levels were monitored continuously. Actuator operational performance was monitored periodically, as were the characteristics of components (insulation resistance, resistance, impedance), to establish degradation rates and damage thresholds. (auth)

12213 (GEAP-3342) IRRADIATION AND POST-IRRADIATION EXAMINATION OF N.S. SAVANNAH TEST FUEL ELEMENT S1-a. Zimmerman, D. L. (General Electric Co., Pleasanton, Calif. Vallecitos Atomic Lab.). Jan. 28, 1960. Contract AT(04-3)-189. 70p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A modified N. S. Savannah Core I fuel element (S1-a) was irradiated to an average exposure of 1980 MWD/ton in the VBWR. The peak heat flux experienced by the element was 240,000 BTU/hr-ft^2. Post-irradiation examination revealed no evidence of mechanical damage, corrosion, or significant dimensional changes. The maximum fission gas released during irradiation, as determined by post-irradiation ^{85}Kr measurements, was 0.67%. No evidence of fuel melting was observed and extensive pellet fragmentation was limited to peak burnup regions. An apparent fuel density increase of 4% was observed. Metallographic examination revealed no significant ferrule braze or end cap weld damage. The peak ^{235}U burnup, as determined by radiochemical analysis, was 9.4%. (auth)

12214 (MND-3315-1) PM-3A NUCLEAR POWER PLANT HAZARDS SUMMARY REPORT. DESCRIPTION OF PLANT EXPERIENCE AND CHANGES. Fox, C. H.; Guenther, E.; Hall, W.; Hassell, L. D.; McNeil, J.; Riggs, C.; Rosenthal, H.; Vogele, W.; Wischow, R. (Martin Co., Baltimore, Md.). Jan. 1964. Contract AT(30-1)-3315. 88p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For purposes of hazards review, the changes made in the PM-3A Nuclear Power Plant since December 1962 are summarized. Included is a summary enumerating previously submitted documents

presenting PM-3A hazards evaluations, plant design, and changes, and recent reports being released for hazards review at this time are referenced. Information on plant experience, analyses, and equipment changes is presented. Areas covered are control rod drive mechanisms, hydrogen sources and control, containment leak testing, nuclear instrumentation, plant chemistry, radioactive waste processing, airborne activity experience, and miscellaneous plant modifications. (auth)

12215 (MND-M3A-3108(Pt,B)) RADIOACTIVE IODINE RELEASE FROM PM-3A CONTAINMENT VESSELS. Riggs, C. O.; Hassell, L. D. Jr. (Martin Co., Baltimore, Md.). Nov. 15, 1963. Revised Jan. 28, 1964. Contract AT(30-1)-3108. 29p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A conservative analysis of the I_2 release from the PM-3A nuclear power plant for leak rates to 5 percent per day and different meteorological conditions establishes that the 72 hour integrated dose to the thyroid would not exceed 243 rads in the worst case. It is concluded, therefore, that undue hazard to personnel does not exist in the event of a maximum credible accident. (auth)

12216 (ORNL-TM-1654) POWER DISTRIBUTION AND REACTIVITY CALCULATIONS FOR THE MH-1A REACTOR. Edison, G. E.; Winton, M. L. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 50p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The power distribution and initial reactivity were calculated for the MH-1A reactor reference design and for several design variations. For the reference design, the power peaking and reactivity results were in good agreement with values previously calculated by the Martin Company and with the experimentally determined initial reactivity. Removal of B from the control rod followers increased the power peaking by about 30%. Replacement of the twelve stainless steel dummy rods with 0.9 wt % B-stainless steel shim rods did not change the power peaking appreciably. The dummy rods had only a localized effect on the power distribution. Estimated power margin values for the MH-1A in the steady-state operating condition were acceptable for all the design variations studied. However, removal of B from the followers brought the power margin for transient operation close to the specified limit of 1.2. (auth)

12217 (TID-23425) ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM. OPERATION OF THE ML-1 WITH AIR AS THE WORKING FLUID. Luchter, S.; Swain, R. K.; Varga, S. A. (Aerojet-General Nucleonics, San Ramon, Calif.). May 1963. Contract AT(10-1)-880. 42p. (AN-AGCR-519). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Evaluations conducted in the development of an integrated program for conversion of the ML-1 for operation with air as a working fluid are presented. Effects of the conversion on thermodynamic performance, materials performance, power plant design, system activation, make-up air purity, and the possibility of an oil-vapor/air explosion are considered. In the area of materials performance, data are presented on the air corrosion resistance of low-cobalt Hastelloy X, which is the specified fuel cladding. (H.D.R.)

Rocket and Space Reactors

Refer also to abstracts 10505, 10514, 10526, and 10864.

12218 (ANL-7099) STUDY OF REFLECTOR-BASED CONTROL OF FAST NUCLEAR ROCKET REACTORS. Almenas, K. K. (Argonne National Lab., Ill.). May 1966. Contract W-31-109-eng-38. 82p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A comparative evaluation of a variety of reflector and control materials suitable for use with fast-spectrum, high-performance cores was carried out. The evaluation focused primarily on the control potential of reflector-located control mechanisms, though factors such as weight, volume, and critical mass savings were also considered. It was determined that for most fast-spectrum core-reflector combinations a well-defined optimum control-vane design exists. The dependence of this optimum control span on control-vane thickness and composition was explored in detail. Calculational methods for determining the optimum vane configuration and such ancillary but important aspects as control-vane heating are presented. (auth)

12219 (IDO-17167) STEP PROJECT. Quarterly Technical Report, October 1965–December 1965. Dietz, K. A. (ed.) (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Sept. 1966. Contract AT(10-1)-205. 139p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The feedback energy reactivity coefficient for the coupled-drum impulse transient tests was evaluated as part of the SNAPTRAN-1 test program. Results of the evaluation indicate that within the range from zero to 5.5 MW-sec energy release, the feedback coefficient is equal to 0.139 ± 0.022 $/MW-sec. The SNAPTRAN-2 scram and coupling clutch systems were tested to evaluate the scram capability and to determine the effectiveness of the coupling clutch clamp in synchronizing impulse drum motion. The total reactivity swing was $9.25 ± 0.05 with an excess reactivity of $5.05 ± 0.05. The methods and data used to obtain diffusion theory constants for LOFT nuclear design studies were revised to improve the accuracy of reactor physics calculations. The effective multiplication factor was calculated for three critical experiments to evaluate the accuracy of the calculational techniques and parameters. The use of revised group constants resulted in significantly improved criticality predictions. A two-dimensional depletion calculation was made to determine the excess reactivity required at the beginning-of-life for the reactor to operate at full power for 1600 hr. The excess reactivity calculated was 0.072. The BURST digital computer program for calculating acoustic wave behavior during blowdown was extended to treat a subcooled system with variable cross-sectional areas in one dimension and with zero initial fluid velocity. The results obtained indicate that the technique of treating variable-area piping systems during blowdown by utilizing adapter sections produces reasonable results. Numerical results from three mathematical models for nuclear reactor core meltdown analysis following a loss-of-coolant accident were obtained. Results from the explicit pin model show the significance of conductive and radiative heat transfer on the angular and radial temperature distribution. For the particular studies made, comparisons of the results from the explicit pin model with the results from a lumped X-Y model show good agreement. Results from the annular ring model demonstrate the feasibility of using a lumped annular ring concept to describe axial and radial radiative and conductive heat transfer. The effect of the Zr-steam chemical reaction on temperature distribution is shown to be important in meltdown analysis. The temperature decay of the inside surface of the LOFT containment for the first 26.6 hr following blowdown was calculated using the digital computer code, CONTEMPT. A maximum inside containment atmospheric temperature of 216.1°F occurs during blowdown. Pressure in the containment decreases to zero after 26.6 hr. Tests were conducted in which measurement of the residual strain of the SNAPTRAN 2/10A fuel pin cladding was made at room temperature to furnish information to aid in interpreting the strain data obtained during SNAPTRAN-1 transient tests. Residual strain values were obtained at several pin locations for maximum strains up to 3000 μin./in. (J.R.D.)

12220 (IDO-17186) STEP PROJECT. Quarterly Technical Report, January–March 1966. Dietz, K. A. (ed.) (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Nov. 1966. Contract AT(10-1)-205. 77p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The SNAPTRAN-2 reactor destructive test was performed January 11, 1966, using a specially equipped version of a SNAP-10A/2 reactor. Data are presented concerning the nuclear behavior of the reactor and the physical and radiological consequences as the result of the instantaneous addition of essentially all of the reactivity available. Cloud fallout, dose rate, and particle size were measured as the radioactive cloud dispersed. Temperature distribution, fuel depletion, and gamma heating calculations were performed as part of the LOFT nuclear design studies. The BURST digital computer program, used for LOFT blowdown analysis, was extended to treat variable-area systems, and results for a simple geometry were compared with those from acoustic theory. The BURST results were also compared with data from the semiscale blowdown tests. The initial exploratory phase of the core meltdown model development was completed for the X-Y and annular ring models. Data concerning the effect of aging on the contamination of coatings and on the effectiveness of decontamination treatments were obtained. The first meltdown of irradiated fuel in the Contamination-Decontamination Experiment was completed and fission product plateout samples were analyzed. Semiscale blowdown tests were performed at elevated temperatures and pressures, and a thrust-cancelling device attached to the blowdown nozzle of the semiscale vessel was evaluated. (H.D.R.)

12221 (N-66-19135) DYNAMIC ANALYSIS OF A LITHIUM-BOILING POTASSIUM REFRACTORY METAL RANKINE CYCLE POWER SYSTEM FOR THE JET PROPULSION LABORATORY. Poppendiek, H. F.; Sabin, C. M.; Feigenbutz, L. V.; Morton, W. A.; Connelly, D. A. (Geoscience Ltd., La Jolla, Calif.). Nov. 1965. Contracts NAS7-100; JPL-951198. 133p. (NASA-CR-70371; GLR-39). CFSTI $3.00 cy, $0.65 mn.

For Jet Propulsion Lab., Pasadena, Calif.

A number of steady state and transient analyses of idealized models of the lithium–boiling potassium Rankine cycle space power system is presented. The unique aspects of liquid metal Rankine power systems are considered and simplified equations

which define the nuclear reactor and power system components are given. Also, system simulation models and the governing equations are included. (STAR)

12222 (NASA-CR-695) THEORETICAL INVESTIGATION OF RADIANT HEAT TRANSFER IN THE FUEL REGION OF A GASEOUS NUCLEAR ROCKET ENGINE. Kesten, A. S.; Krascella, N. L. (United Aircraft Corp., East Hartford, Conn.). Jan. 1967. Contract NASw-847. 28p. CFSTI $3.00 cy, $0.65 mn.

A series of calculations were made to determine temperature distributions in the fuel-containment region of gaseous nuclear rocket engines which are based on the transfer of energy by thermal radiation from the fuel to the propellant. Temperature distributions were determined for two sets of fuel opacities; the opacities in each of these sets were calculated from an analytical heavy-atom model using two recent theoretical estimates of fuel ionization potentials. The temperatures near the centerline of the fuel-containment region were found to be high and relatively insensitive to changes in fuel opacity. (auth)

12223 POST-IRRADIATION CHEMICAL ANALYSIS OF SNAP-8 EXPERIMENTAL REACTOR COOLANT. Broom, Knox M. Jr.; Bingham, Carleton D.; Crockett, Thomas B.; Trahey, Nancy M. (Atomics International, Canoga Park, Calif.). Nucl. Appl., 2: 519-23(Dec. 1966).

An experimental program involving radiochemical and spectrochemical analysis of short-cooled samples of SNAP-8 Experimental Reactor (S8ER) primary coolant is described. Evidence for the presence of corrosion products, fission products, and coolant activation products was sought. Gamma-ray spectrometric and dc-arc emission spectrographic techniques and the methods for determining a sensitivity for detection are described. Experimental data revealed essentially no detectable corrosion-product activities in the NaK. Fission product ^{137}Cs was clearly observed. Fission products other than ^{137}Cs, ^{131}I, ^{132}Te, ^{132}I, and ^{125}Sb were not observed using spectrum stripping techniques. Sources of other observed radionuclides are proposed. Corrosion-product and fission-product activities were observed on primary cold trap and piping surfaces. (auth)

Process Heat and Desalination Reactors

12224 (ORNL-TM-1152(Rev.)) A PRELIMINARY INVESTIGATION OF LOW-TEMPERATURE, LIGHT WATER-COOLED AND MODERATED, SLIGHTLY-ENRICHED URANIUM METAL FUELED REACTORS FOR LARGE SINGLE-PURPOSE NUCLEAR DESALTING PLANTS. Chapman, R. H.; Gift, E. H. (Oak Ridge National Lab., Tenn.). Dec. 1966. Contract W-7405-eng-26. 41p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Low-temperature, light water-cooled and moderated, slightly enriched U metal fueled reactors show significant savings in capital and fuel cycle costs in relatively large, single-purpose desalting plants. A preliminary study was performed to determine current fuel limitations and approximate heat costs. Reactors of 1500 and 3500 MWt, sufficient for producing 150 and 350 Mgd of fresh water, respectively, when coupled to water plants having performance ratios of about 10, were studied. With reactor coolant temperatures in the range of 250 to 350°F, significant savings in reactor plant capital costs result from the low pressure required to supress boiling and the relatively low energy content of the coolant to be contained. This temperature range also permits direct coupling of the water plant to the primary coolant circuit through the brine heaters, thus eliminating the cost of an intermediate heat transfer system. The effects of density and self-shielding of lumped uranium metal in relatively dry lattices are to increase the fast fission effect and the conversion ratio, resulting in higher neutron economy and lower fuel cycle cost. Fuel cycle costs will be in the range of 4.40 to 5.90¢/mBtu for the 1500 MW(t) reactor and 3.85 to 5.40¢/mBtu for the 3500 MW(t) reactor. The range is reported to reflect uncertainties in the physics calculations and burnup level. Thus it is expected that heat cost will be in the range of 13.5 to 15.5¢/mBtu for the 1500 MW(t) reactor and 10.0 to 11.5¢/mBtu for the 3500 MW(t) reactor. (auth)

12225 (ORNL-TM-1640) FLEXIBILITY OF A DUAL-PURPOSE PLANT TURBINE WITH LOWERED DESIGN EXHAUST PRESSURE. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Jan. 1966. Contract W-7405-eng-26; Subcontract No. 2504. 30p. (ACNP-66508). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Oak Ridge National Lab., Tenn.

Work to determine the improvement in performance and its accompanying increase in cost for a single turbine-generator unit rated at 500 MW when operating at 600 psig throttle pressure and 35.4 psia normal exhaust pressure, and having a design exhaust pressure of 20.0 psia is reported. In comparison with a previous 35.4 psia exhaust pressure turbine design, the 20.0 psia unit has one additional stage in each half of the double flow machine, an increase in the bearing center-line distance of 3 ft 6 in., and considerably altered blade designs, particularly toward the exhaust end. The steam cycle was retained unchanged from the previous study. Plots are presented giving the power output, the heat exhausted to the water plant, and the temperature of the feedwater returned to the reactor system as a function of exhaust pressure from 35.4 psia down to 7.0 psia and of throttle flow from approximately 25% of full flow up to full flow. Other plots showing turbine expansion lines on Mollier diagrams, turbine heat rates, turbine exhaust enthalpies and flows, and gland-sealing steam requirements are included. The extra cost of this turbine-generator in comparison to the previously studied 35.4 psia design exhaust pressure unit is given, as well as the additional cost for obtaining continuous safe full-flow operation of this unit at an exhaust pressure of 7.0 psia. Decreasing the design exhaust pressure of the turbine improves the flexibility of the turbine-generator plant without any reduction in performance at normal operating conditions. (J.R.D.)

12226 (ORNL-TM-1657) SPECULATIVE ANALYSIS OF LARGE VAPOR COMPRESSION SYSTEMS FOR NUCLEAR DESALINATION PLANTS. Burwell, C. C.; Johnson, J. E. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 44p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A thermodynamic and economic evaluation of vapor compression (VC) systems to supply heat for desalination processes has been undertaken so that the incentives for developing VC systems for large (greater than 100 mgd) water-only evaporators might be ascertained. The study was limited to energy supply and coupling and did not include detailed analysis for coupling the evaporator to the vapor compressor. Since the VC system recovers and recycles heat, expressions have been developed to estimate the increased availability or heat gain that may be achieved. By factoring in economic considerations, such as prime nuclear heat cost and turbine-compressor investment, thermoeconomic expressions are derived. Using the analytical procedures developed, case studies were prepared for projected compression equipment and nuclear heat costs to evaluate the economic effectiveness of vapor compression systems. From these studies it is shown that vapor compression systems provide the greatest economic benefit when prime energy costs are high. However, it appears that advanced reactor systems, with low heat cost will be able to supply heat more economically when directly coupled to evaporators than when coupled through a vapor compressor. (auth)

12227 APPLICATION OF NUCLEAR ENERGY TO LARGE-SCALE POWER AND DESALTING PLANTS. Siegel, Sidney; Golan, Simcha; Falcon, Joseph A. (Atomics International, Canoga Park, Calif.). Nucl. Eng. Design, 4: 225-32(Oct. 1966).

There is a current widespread interest in dual-purpose nuclear plants, attributable to successful developments in both the nuclear and desalination fields. During the past year, it has become clear that nuclear power can compete economically with fossil fuel power in many geographical areas. At the same time, parallel strides have been made in the technology and economics of seawater conversion, particularly in distillation processes. These developments have opened the way for consideration of large-scale plants which can supplement both the electrical energy and fresh water needs of large metropolitan areas near the coast. Specific types of nuclear power plants in combination with desalting plants are examined to establish the relative economic potential of various heat sources for large-scale dual-purpose application. (auth)

12228 FEASIBILITY OF OFFSHORE DUAL-PURPOSE NUCLEAR POWER AND DESALINATION PLANTS. Arnold, H. G.; Gall, W. R.; Morris, G. (Oak Ridge National Lab., Tenn.). Nucl. Eng. Design, 4: 311-21(Oct. 1966). (ORNL-P-2517).

Discussion of the ecological and technical reasons suggests offshore locations for dual-purpose nuclear power and desalination plants to be an attractive solution to the siting problem. A study on the feasibility of offshore construction of such dual-purpose nuclear plants shows that the necessary technological experience is available from applications for other purposes such as offshore oil wells, bridge caissons, floating drydocks, and other marine structures. Conceptual design studies for a large-scale nuclear power and desalination plant using alternatively an island caisson, a deep-water caisson, and a moored floating platform are described. Comparative cost estimates for onshore and offshore dual-purpose nuclear plants are made. (auth)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 12151 and 12189.

12229 (ANL–7157) DESIGN, PERFORMANCE, AND EVALUATION OF SHIELDING WINDOW FOR FARET CONTAINMENT CELL. Eckels, T. W.; Smaardyk, A. (Argonne National Lab., Ill.). July 1966. Contract W-31-109-eng-38. 26p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A shielding window design for use in a reactor containment structure is evaluated. The design is accomplished by the appropriate placement and sealing arrangement of thick glass slabs. Conservative capability to withstand, without damage, over two times the required design pressure of 30 psig has been achieved. High resistance to potential missile damage has been included, mainly by the ability of the first slab to absorb impact while protecting successive slabs. For extreme temperature conditions associated with "maximum credible accident" criteria, tests have demonstrated the window integrity in the same manner of protection. In this case the first slab, even if cracked, would serve as an insulating member protecting the next slabs. A high degree of visibility has been achieved by the selective arrangement of windows, adequate glass area, and a combination of glass slab sizes and thicknesses resulting in desirable angles of view. In addition, EBR-II design features for replacement of glass components have been incorporated in a manner such that replacement may be done while the integrity of the cell is maintained. (auth)

12230 (ANL–7244) PRELIMINARY DESIGN STUDY OF NEUTRON-SPECTRUM CONVERTER FOR USE IN THE JUGGERNAUT REACTOR'S EAST THERMAL COLUMN. Herbst, Dale A.; Talboy, James H. (Argonne National Lab., Ill.). July 1966. Contract W-31-109-eng-38. 33p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A design study has been made for a neutron-spectrum converter for Juggernaut's east thermal column. Calculations were performed to determine: (1) the ^{235}U and ^{10}B burnup rates, (2) the neutron-flux distribution, and (3) the heat generation and resulting temperature profiles in the converter assembly. Results of calculations indicate that a practical design has been established. (auth)

12231 (ANL–7267) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, OCTOBER 1966. (Argonne National Lab., Ill.). Nov. 22, 1966. Contract W-31-109-eng-38. 98p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Measurements of the uniform temperature coefficient of reactivity of the fully loaded EBWR core with eight spike assemblies in the first shim zone between room temperature and 360°F were made with boric acid concentrations near 6 g/gal. The temperature coefficient is positive at low temperatures, becomes very small as the temperature is raised, and apparently becomes negative before 360°F is reached. With planned modifications and maintenance on EBR-II completed during the recent scheduled shutdown, Run No. 22, projected for 1000 MWd, was begun on October 21. Almost half of this run was completed at month's end. Thirty-two of 54 total piling foundation holes for the ZPPR were completed. The floor slab and foundation for the vault-workroom and service floor of the support wing were poured. Detailed reports of measurements made in ZPR-3 during the last four months on Assembly 48, a large, clean, plutonium-fueled core, were compiled and a summary is presented. The AARR Title I report was submitted to the AEC for approval on October 7, 1966. The AARR core design was changed to a HFIR type, and all research and development work on the stainless steel cermet fuel was terminated. (auth)

12232 (BAW–3647-2) PHYSICS VERIFICATION PROGRAM. Quarterly Technical Report No. 2, July–September 1966. (Babcock and Wilcox Co., Lynchburg, Va.). Nov. 1966. Contracts AT(30-1)-3647; 41-2007 (RDE-1526). 71p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The results of critical experiments on cores IV, V, and VI are reported. In all assemblies the basic lattice consisted of 0.475-inch-OD rods of 2.45%-enriched UO_2 arrayed on a square pitch of 0.644 inch and moderated by H_2O. The water was poisoned with H_3BO_3 (about 1.5 gm B/ℓ) to obtain critical assemblies approximately 5 feet in diameter. The reactivity worth of Ag–In–Cd control pins arranged in configurations typical of power reactors was measured in these cores. The results of measurements of ρ_{28}, the modified conversion ratio, and the epithermal neutron spectrum are also reported. (auth)

12233 (BNWL–328) A TWO STAGE 2100 DEG F HELIUM GAS HEATER FOR THE ATR MODEL GAS LOOP. Evans, R. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1966. Contract AT(45-1)-1830. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A gas heater incorporating the major design features of the Advanced Test Reactor (ATR) gas heater was built, installed, and operated successfully in the one-tenth scale model loop. The design, fabrication, and technical problems encountered are discussed. (H.D.R.)

12234 (BNWL–342) SHIELDING CALCULATIONS FOR IRRADIATED FTR FUEL. Bunch, W. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1966. Contract AT(45-1)-1830. 21p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Shielding calculations have been made for irradiated FTR fuel to provide systems engineers with a basis for conceptual design of those facilities that are to contain this material. Gamma intensity as a function of shield thickness was obtained for several materials of interest, including lead, tungsten, depleted uranium, concretes of various density, water and air. Heat generation as a function of decay time was also calculated for evaluation of cooling requirements. A preliminary estimate of neutron generation rate in irradiated fuel indicated that special neutron shielding will only be required if beryllium is contained within the fuel. (auth)

12235 (GA–6957) THE NATURE OF CONDENSABLE FISSION PRODUCTS IN AN HTGR ENVIRONMENT. Busch, D. D. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Apr. 15, 1966. Contract AT(04-3)-167. 26p. (CONF-660520–4). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Symposium on the Decontamination of Nuclear Installations, Harwell, Eng.

Studies were performed in the General Atomic In-pile Loop to provide information on the behavior of condensable fission products in a simulated high-temperature gas-cooled reactor environment. A diffusion-tube technique was used to determine the chemical form and concentration in which each fission product is available for reaction with coolant-system surfaces. Diffusion tubes were inserted monthly at three positions in the loop. Operating temperatures were approximately 510°C, 330°C, and 170°C, respectively. Diffusion coefficients were determined for a number of nuclides, including ^{131}I, ^{133}I, ^{134}Cs, and ^{137}Cs. Iodine and cesium normally had diffusion coefficients ranging from 0.03 to 0.1 $cm^2\ sec^{-1}$, depending upon the temperature, indicating their presence in the helium coolant in monatomic form. Barium-140 was deposited uniformly throughout each diffusion tube, indicating local decay of its precursor, ^{140}Xe. Partial pressures were calculated from the total amount of each fission product deposited in the diffusion tube. They ranged from about 2×10^{-15} atm for ^{131}I to about 6×10^{-13} atm for ^{137}Cs. The partial pressure of ^{140}Xe calculated from ^{140}Ba data was approximately 2×10^{-15} atm. (auth)

12236 (IDO–17202) NUCLEAR TECHNOLOGY BRANCHES QUARTERLY REPORT, APRIL 1–JUNE 30, 1966. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Nov. 1966. Contract AT(10-1)-205. 47p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The power distribution in the ATRC was remeasured with better accuracy in determining the hot-spot fission rate. The radial profile of the void coefficient of reactivity in the ATRC fuel annulus was found to be more negative than anticipated. The excess reactivity of the ATRC 39-kg core was measured by uniformly poisoning the reactor. Pulsed-neutron apparatus and experimental procedures used in the Critical Facilities section are summarized. The worths of the ATRC safety rods were measured in various shim configurations using both the pulsed-neutron and rod-drop methods. With the latter method, the effect of the location of the neutron detector was investigated. The worth of the ETRC safety rods was measured using the pulsed-neutron method. It was demonstrated in these measurements that the rod-worth values were generally independent of neutron-generator–neutron-detector geometry. Results of inspections of ATR fuel elements fabricated under the first production contract are reported. The majority of the fuel elements appear satisfactory for ATR use. Engineering calculations upon radially zone-loaded ATR fuel elements showed lower plate temperatures and axial buckling stresses in comparison with the uniformly loaded, Mark-IV reference fuel. Thermal compatibility studies were conducted on dispersions of UAl_3 particles in 300 Series stainless steel, Cr, Ni, and Nb. Samples were prepared by powder metallurgical techniques, heat-treated, and examined. Metallographic, x-ray-diffraction, and electron-beam microprobe examinations were used to determine compatibility. At 800°C, the UAl_3 reacted only slightly with stainless steel and appeared compatible with the remaining materials. At 1200 to 1250°C, the UAl_3 underwent extensive reaction and diffusion with all of the matrix materials tested. Compatibility tests between liquid Pb, Sn, and Bi and UAl_3 fuels showed that liquid

lead should be a satisfactory heat transfer medium up to 600°C for short term use. (auth)

12237 (LA-DC-8094) BEHAVIOR OF FISSION PRODUCTS IN SODIUM. Clifford, John C.; Williams, James M.; McGuire, Joseph C. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 18p. (CONF-661110-6). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna, Austria.

The behavior of ^{137}Cs in the small-scale experiments and in previous LAMPRE experiments present a qualitatively consistent picture of elemental Cs as a mobile and volatile species. Cs appears to be only weakly adsorbed on metal surfaces and, over long periods of time, it migrates to cool gas spaces. The presence of a Na_2O cold trap in the flow circuit appears to have little effect on this behavior. Cs forms lamellar compounds with graphite (C_8Cs, $C_{24}Cs$), so the effectiveness of graphite surfaces over metal surfaces as Cs collectors is not entirely unexpected. However, the desirability of placing large surfaces of graphite in a Na system, and the long-time effectiveness of graphite as a Cs scavenger are doubtful. These uncertainties do not preclude the use of a graphite bed in the vapor phase. The temperature dependent fractionation of Pu, ^{90}Sr, ^{155}Eu, and ^{106}Ru observed in the forced convection sodium system, while not impressive in terms of coolant decontamination, suggests that selective concentration of some fission products may be possible. The factors of 20-50 difference in species activity levels between high- and low-temperature Zr traps might be increased another factor of 5 or 10 by the use of extended surface metal adsorbers within the system. The source of activity was primarily a liquid metal in which all fission product species very likely existed in the fully reduced state. Transfer of these species from fuel to sodium probably was a simple solution step. Departures from this condition, brought about by substitution of oxide and carbide fuels for the liquid Pu-Co-Ce alloy, have hot been considered. (auth)

12238 (N-66-23840) PRELIMINARY HAZARDS SUMMARY FOR NERVA IRRADIATION TESTING AT PLUM BROOK REACTOR FACILITY. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Jan. 1963. 39p. CFSTI $3.00 cy, $0.65 mn.

Details are presented for a program to evaluate hazards that may be encountered during irradiation testing in a simulated NERVA environment at cryogenic temperatures. Prior to the initiation of any NERVA irradiation testing on the horizontal through tube (HT-1) at the Plum Brook reactor facility, reactivity tests will be run on the actual capsule or a mockup of same. Necessary equipment and facilities are described, along with the environmental control system. Design of the capsule insertion and removal system will be such that an operator can easily and rapidly carry out an emergency withdrawal of the capsule to protect the reactor from damage and unnecessary shutdown; certain experiment conditions are listed, however, which should cause an automatic shutdown. A maximum credible accident is presented, and various procedures for specified failures are considered. (M.W.R.)

12239 (WAPD-T-1943) THERMAL DISADVANTAGE FACTOR MEASUREMENTS IN HIGHLY ABSORBING BORON PLATE LATTICES IN A CONSTANT-POWER CRITICAL FACILITY. Dateo, F. H.; Galey, J. A. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Sept. 1966. Contract AT(11-1)-Gen-14. 18p. (CONF-661001-37). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 14th Conference on Remote Systems and Technology, Pittsburgh, Pa.

Thermal disadvantage factor measurements were made in a square boron plate-water lattice test assembly located in the center of the fuel region of a reactor. The measurements consisted of determining the specific activity induced in Dy-Al foils by the reaction $^{164}Dy(n,\gamma)^{165}Dy$ during constant power critical reactor operations. Experimental results are compared with calculations using the MARC program, which solves the neutron transport equation in the thermal energy range by the Monte Carlo Method. (H.D.R.)

12240 (WAPD-TM-580) INVESTIGATION OF INTEGRAL FUEL ROD SPACER FABRICATION TECHNIQUES. Fischer, R. L. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Dec. 1966. Contract AT(11-1)-Gen-14. 34p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Manufacturing procedures were investigated to provide projections on the outside diameter (OD) of fuel rods with length to diameter ratios greater than 30 to 1. The projections were designed to provide lateral rod-to-rod spacing within close-packed clusters of fuel rods. Various joining and forming techniques were used to fabricate projections on developmental quantities of Zircaloy cladding tubes. These techniques and the procedures utilized to evaluate the product are described. (auth)

12241 CRITICAL DIMENSIONS OF WATER-REFLECTED SYSTEMS CONTAINING $^{235}U-H_2O-Zr$. Rutledge, G. P.; Dobbe, F. A.; Price, C. H. (Westinghouse Electric Corp., Idaho Falls, Idaho). Nucl. Appl., 2: 461-7(Dec. 1966).

Calculated values of the extrapolation distance for water-reflected $^{235}U-H_2O-Zr$ ternary systems are presented. This extrapolation distance, together with previously published critical buckling data, permits the determination of critical dimensions for all possible compositions of this system. Limited data were previously available for the extrapolation distance for the $^{235}U-H_2O$ binary system, and no data existed for the ternary system. A quantitative determination of the extrapolation distance was achieved utilizing, in a unique manner, nuclear codes developed for reactor design purposes. Accuracy of the results was confirmed at compositions for which experimental data are available. The extrapolation distance was found to be essentially independent of the shape of the system but strongly dependent upon composition. A single diagram that presents critical buckling and extrapolation distance as a function of composition was developed. With this diagram it is possible to determine critical dimensions for a given shape and composition and optimum conditions for criticality. As an important practical example, the minimum critical limits for optimally water-moderated cylindrical arrays of $^{235}U-Zr$ fuel elements are presented as a function of fuel-element length and composition. (auth)

12242 THEORY OF ROSSI-ALPHA EXPERIMENT IN REACTOR NOISE STUDIES. Babala, Dusan (Institutt for Atomenergi, Kjeller, Norway). Nucl. Sci. Eng., 26: 418-19(Nov. 1966).

A serious disagreement has been observed between the theory of the Rossi-α experiment and measurements performed in the NORA reactor. The two types of measurement techniques generally used in Rossi-α experiments are described and the cause of disagreement between theory and experiment is pointed out. (H.D.R.)

12243 THERMAL-COLUMN PNEUMATIC RABBIT FACILITY. de Saint Maurice, A. B.; Weeks, T. C.; Canfield, R. T. (Reactor Labs., Inc., Plainsboro, N. J.). Nucl. Appl., 2: 294-8(Aug. 1966).

A pneumatic rabbit facility has increased the flexibility of a graphite thermal column at a 5-MW pool research reactor by providing accessibility during full power reactor operation. Previously, sample insertions and removals were possible only during reactor shutdown periods. The unique feature of the pneumatic facility is that the rabbit track and vent line were machined in two standard graphite stringers which, when connected end-to-end, provided full penetration of the thermal column. The S-shaped contoured track precludes radiation streaming, and the graphite surface is ideal for rabbit travel, eliminating the necessity of a liner that could present flux perturbation and column contamination problems. (auth)

12244 THE PROBLEM OF FUEL BURNUP IN VVR-S.I.A.F. REACTOR DURING LOADING. Udrea, I.; Mentesku, L.; Kharga, K.; Popa, P.; Chepraga, D. Rev. Roum. Phys., 11: 505-11 (1966). (In Rumanian).

The partial replacement and redistribution of fuel in order to achieve a more efficient fuel consumption in the heterogeneous reactor VVR-S I.A.F.-Bucharest resulted in considerable variation of fuel burnup in individual bundles. It is shown that changes in the absorption cross sections produced by the fission products $\Sigma_{FP} = f$ (burnup) should be taken into account. A simplification of the problem was made by applying perturbation theory in one group of neutrons approximating the Σ_{FP} variations by two straight lines and the results are discussed. (tr-auth)

12245 AUTOMATIC CONTROL SYSTEM FOR THE RUMANIAN VVR-S REACTOR. Tsapu, K.; Iftode, I.; Dobresku, K. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 11: 513-17 (1966). (In Rumanian).

Improvements and a further development of a new automatic control system for a VVR-S reactor were tested during experimental operations. An automatic unit for standard time function of all normal reactor operations permitted measuring the exact time of manual startup; the rate of control rod motion controlled by a feedback circuit; the reduced influence of fast parasitic fluctuations on the control rod rate; reduced the number of elements; and simplified the operating conditions. (tr-auth)

12246 MATERIAL BUCKLINGS FOR 1.002, 1.25, and 1.95 WT PERCENT ^{235}U ENRICHED URANIUM TUBES IN LIGHT WATER. Brown, C. L.; Lloyd, R. C. (Battelle Memorial Inst., Richland, Wash.). Nucl. Sci. Eng., 27: 10-15(Jan. 1967). (BNWL-SA-267).

Material bucklings and extrapolation distances were measured for several slightly enriched U-metal tube lattices and tube-in-tube assembly lattices in light water. The tubes measured were: 1.002 wt % ^{235}U enriched U (2.34-in. OD; 1.79-in. ID); 1.25 wt % ^{235}U enriched U (2.37-in. OD; 1.80-in. ID); and 1.95 wt % ^{235}U en-

riched U (2.28-in. OD; 1.41-in. ID). The tube-in-tube assemblies measured were: 1.002 wt % ^{235}U outer tubes (2.34-in. OD; 1.79-in. ID) containing 1.002 wt % ^{235}U inner tubes (1.18-in. OD; 0.49-in. ID); and 1.25 wt % ^{235}U outer tubes (2.37-in. OD; 1.80-in. ID) containing 0.95 wt % ^{235}U inner tubes (1.18-in. OD; 0.48-in. ID). Maximum bucklings for the tubes were found to be 25.00, 47.00, and 83.00 m^{-2}, respectively; and for the tube-in-tube assemblies, 23.50 and 38.50 m^{-2}, respectively. Based on the measurements, critical parameters for use in nuclear safety analyses were calculated. (auth)

12247 NEUTRON SPECTRUM MEASUREMENT IN A FAST CRITICAL ASSEMBLY. Bennett, E. F. (Argonne National Lab., Ill.). Nucl. Sci. Eng., 27: 28-33(Jan. 1967).

The neutron spectrum at the center of a large, dilute fast reactor was measured over the energy interval from 1 keV to 1 MeV. Resolution of the measurement was about 20% (FWHM) except at the lower energies. Errors in the measurement are described and a comparison made of the measured result with a multienergy-group calculation. There exists fair agreement between the measured spectrum and the multigroup calculation. (auth)

12248 DIRECT DETERMINATION OF ^{235}U CAPTURE-TO-FISSION RATIO IN A ZERO-POWER REACTOR. Redman, W. C.; Bretscher, M. M. (Argonne National Lab., Ill.). Nucl. Sci. Eng., 27: 34-44(Jan. 1967).

An experimental method for the determination of the spectral average of the capture-to-fission ratio $\bar{\alpha}$ for materials inserted in a low-flux reactor is described. The procedure involves a comparison of reactor response to oscillated samples of a fissile material, an absorber, and a spontaneous fission neutron source, plus an experimental determination of fission rate for the fissile material and capture rate for the absorber. In addition, it is necessary that the neutron source be calibrated. These experimental results, combined with a knowledge of the number of neutrons per fission for the fissile material, yield a value of the quantity $1 + \bar{\alpha}$. This method has been tested in Hi-C Core 10, a critical assembly of 3%-enriched-UO_2 fuel pins, moderated and reflected by light water, in a lattice spacing which yields a H-to-^{238}U atom ratio of 2:91. The oscillator and absolute counting data yield a value of 0.217 for the central capture-to-fission ratio of ^{235}U, with a standard deviation of ±0.015. This agrees well with values derived from a combination of measured ^{235}U fission cadmium ratios and calculated thermal and epithermal values for α. (auth)

12249 RG-1 REACTOR FOR GEOLOGICAL RESEARCH. Bulkin, Yu. M.; Zhirnov, A. D.; Konstantinov, L. V.; Nikolaev, V. A.; Stenbok, I. A.; Lobanov, V. S.; Benevolenskii, A. M. At. Energ. (USSR), 21: 319-21(Oct. 1966). (In Russian).

The reactor described is of the swimming-pool type rated at 5 kW(t). It is intended for the production of radioactive isotopes with different half-lives, for activation analysis of technological and geological samples, for estimates of the absorbing abilities of solid and liquid materials and alloys, and for use in conjunction with a group of laboratories for the development of new engineering and technical research methods using radioactive isotopes. The fuel is UO_2 (10% enrichment) and the critical load is 2.6 kg of ^{235}U. The reflector is made of graphite blocks clad in aluminum. The core and reflector are placed in a water-filled aluminum tank. Boron steel control rods are used. There are altogether seven different channels located in areas with different thermal and fast neutron flux densities. The maximum productivity reaches 2600 millicurie when 8 standard ampoules with $KMnO_4$ are used. The auxiliary equipment used to handle the radioactive material and to control the reactor are briefly described. (ATD)

12250 BURST CAN DETECTION SYSTEM UTILIZING COMBINED FISSION GAS MONITORING AND ELECTROSTATIC PRECIPITATION. Strindehag, O. (Aktiebolaget Atomenergi, Studsvik, Sweden). Nucl. Instrum. Methods, 48: 45-55(Feb. 11, 1967).

A burst-can detection system is described whose detector unit can be used both for fission gas monitoring and electrostatic precipitation. The system when installed in a reactor test loop showed a very high sensitivity when calibrated with Zr/U foils. The expected response of the system to defects of pin-hole type ($\nu = 10^{-8}$/s) is 1.8×10^3 cps, and the normal background for the measured transport time from reactor to detector of 107 sec is 11 cps. This background, which is mainly due to the ^{16}N activity of the coolant, can be significantly reduced by increasing the transport time. (auth)

12251 ACTIVATION ANALYSIS NUCLEAR REACTOR AND SPOOL-LIKE FUEL ELEMENT THEREFOR. Leonard, Byron H. Jr. (to Internuclear Co.). U. S. Patent 3,274,064. Sept. 20, 1966. Filed Oct. 24, 1960.

A small nuclear reactor consisting of three major components, the reactor package, the instrumentation package, and the biological shield, and fuel elements for the reactor are described. The reactor is intended for activation analysis work and is prefabricated for subsequent installation requiring only water and electrical connections. The reactor package includes a main pressure vessel, a core formed of a number of the fuel assemblies supported in the main pressure vessel, a system connected with the pressure vessel for circulating a fluid moderator in a given path at different rates through the reactor, and a regulator means movable toward and away from the core for controlling the reactivity level in the core and located in the path of moderator flow. The regular means operates in response to changes in flow rate of the moderator. The fuel assemblies are spool-like and include a tubular hub, a pair of flanges with relatively flat faces in spaced axial relation on the hub, and a number of plate fuel elements in a spiral configuration held between the opposing flat faces of the flange. A number of similar spaced spiral guides are formed on the opposing flat faces of the flange for holding the edges of the fuel elements. A securing means is provided for holding the assembly together and for acting as a locating means for placement of the assembly. (B.L.M.)

Production Reactors

Refer also to abstract 12151.

12252 HANFORD'S NEW PRODUCTION REACTOR. Nucl. Eng. Design, 4: 299-310(Oct. 1966).

The New Production Reactor (100-N Reactor) is dual-purpose, producing Pu, electrical power, and important isotopes for industry and research. The reactor achieved criticality as of December 1963 and the first electrical power was produced in April 1966. The origin of the dual-purpose NPR project and a description of the facilities are presented. (J.R.D.)

12253 ON-LINE COMPUTER ASSISTANCE TO REACTOR OPERATION AT SAVANNAH RIVER PLANT. Gimmy, K. L.; Field, F. R. Jr. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Nucl. Appl., 2: 280-6(Aug. 1966). (DPSPU-65-30-16).

An on-line digital computer is used to improve operating safety and efficiency of a large production reactor at the Savannah River Plant. About 3250 instrument sensors are scanned in a 4½-min cycle; signals and computed results closest to limits are displayed to the reactor operator. Automatic alarm programs identify an exceeded limit, a change in normal fuel-coolant temperature distribution, or a failed sensor. Demand programs print temperature distributions and flux curves used to adjust reactor power distribution. Computer results are used with existing written procedures for control of reactor operation. (auth)

12254 HAS ATOMIC ENERGY GOT INTO ITS STRIDE? de Laboulaye, H. (Commissariat a l'Energie Atomique, Paris). Energ. Nucl. (Paris), 8: 291-9(July-Aug. 1966). (In French).

The United States marked a turning point in the major peaceful application of nuclear energy in the production of electricity in 1965. Some details of the French program and development of the relative uses of the various reactor systems in France and other countries are reported. When studying the costs of the kWh furnished by classical thermal energy and nuclear energy, the question of the possibility of producing electricity from enriched uranium is raised. The long term problem concerning the possible lack of natural uranium is discussed. The advantages which provide France with sufficient confidence to meet the challenge offered by atomic energy are cited. (auth)

Reactor Components, Fuels and Accessories

Refer also to abstracts 10367–10369, 10373, 11169, 11177, 11289, 11326, and 12231.

12255 (HW-52942) SLIT CAMERA. Brenden, B. B. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Oct. 9, 1957. Contract AT(45-1)-1350. 17p. DTIE.

The slit camera principle and its possible applications to fuel element inspection and meteorology are reported. The principle has been successfully applied to the recording of fuel element surface appearance of externally cooled fuel elements. It could also be a useful tool for recording the appearance of the bore of the internally cooled fuel elements, and for studying cloud distributions and wind patterns. (J.C.W.)

12256 (INR-685/IX/RP) PROBLEM OF REACTOR SHELL. Szymendera, Lech (Institute of Nuclear Research, Warsaw (Poland)). Jan. 1966. 106p. Dep.

The term "Reactor Shell" is used to designate the nuclear re-

actor pressure vessel and shields. General formulation of the problem, including the formal definition of the reactor shell and the set of basic equations describing this object, are given. Because these basic equations consist of neutron- and gamma-transport equations and the thermoelastic equations, which in this problem are in fact coupled by the temperature-variable, a suitable method is presented, which enables all these equations to be solved in coupled form. This is done by application of the perturbation and successive approximation method, which leads to linearization of the problem. (auth)

12257 (LA-3588) XEKE: A TWO-GROUP, TWO-DIMENSIONAL, MULTIREGIONAL COMPUTER CODE FOR EXAMINING FLUX STABILITY IN NUCLEAR REACTORS WITH ^{135}Xe. Sandquist, Gary M. (Los Alamos Scientific Lab., N. Mex.). Sept. 1, 1966. Contract W-7405-eng-36. 95p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

XEKE is a FORTRAN IV coded digital computer program for examining the stability of the time behavior of the neutron flux spacial distribution in a reactor core under the influence of ^{135}Xe. The program employs two-energy-group diffusion type nonlinear kinetic equations to describe the neutron flux and simulates the two-dimensional radial-axial time behavior in multiregion reactor cores with cylindrical geometry and any two-dimensional time behavior in multiregion cores with rectangular geometry. (auth)

12258 (NYO-841-6) THE "DIFFUSION BOARD" CONCEPT IN REACTOR CONTAINMENT. Reist, Parker C.; First, Melvin W.; Silverman Leslie (Harvard School of Public Health, Boston, Mass.). Sept. 1, 1966. Contract AT(30-1)-841. 46p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

In an effort to develop a suitable diffusion board for application to problems of reactor containment, the Harvard Air Cleaning Laboratory staff has investigated a number of materials. These include a carbon-impregnated cellulosic fiber, a rigid porous carbon material, special boards constructed from slagwool and glass fibers, an aluminum honeycomb structure (the so-called Harvard Diffusion Board), and a porous-lined mineral-fiber ceramic board. Although certain of the media possess the required efficiency for removing particulate radioactivity and iodine vapors, all have proven to be deficient in one or more basic aspects, the major one being the problem of steam clogging. Although this can be overcome using preheated metallic filters (for example, copper wool), such an approach is not practical for application under emergency conditions. Future studies directed to the solving of this problem include the use of special methods to prevent wetting of the adsorbents and filters. Also under consideration is the possibility of incorporating into the board certain chemicals that would (upon contact with steam) release substantial quantities of heat (such as the heat of solution, crystallization, etc.). (auth)

12259 (ORNL-3867) ANALYTICAL APPROACH TO WATERLOGGING FAILURE. Kelly, M. J. (Oak Ridge National Lab., Tenn.). Dec. 1966. Contract W-7405-eng-26. 25p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The problem of waterlogging failure of fuel elements is discussed. The problems unique to powder packed elements are treated individually on an analytical basis. Experimental results are correlated with theory and presented in a manner to enable the fuel element designer to make his own judgement values concerning the risks involved. (auth)

12260 (AEC-tr-6839(Pt.2)) PLAIN AND ANTIFRICTION BEARINGS FOR EXTREME REACTOR CONDITIONS. [PART] II. Helfrich, F. Translated from Atomwirtschaft, 9: 168-74(1964). 26p. Dep. mn. JCL $2.60 fs, $0.98 mf.

To satisfy reactor operational requirements for safety and elimination of maintenance, experience is obtained with bearings under extreme reactor conditions. By experimental efforts in Jülich for the AVR high-temperature reactor and by cooperation with the Dragon project in Great Britain, BBC/Krupp was first able to work out design data for bearings in extremely dry He atmosphere. All tests showed the importance of MoS_2 lubricant in reducing friction and wear. The use of grease in ball bearings is also reported. (tr-auth)

12261 MEETING OF A GROUP OF EXPERTS ON THE USE OF ORGANIC LIQUIDS AS REACTOR COOLANTS. Batuecas, T.; Palacios, L. (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid), 10: 329-43(July-Aug. 1966). (In Spanish).

A brief summary of the projects and points of view proposed by the delegates of each country to the OIEA's meeting on the "Use of Organic Liquids as Reactor Coolants" is presented. The general trends are outlined and a summary of each session is given. (G.O.Y.)

12262 DETECTION AND MEASUREMENT OF ^{41}Ar OUTBURSTS AT NUCLEAR REACTORS. Heinzelmann, M.; Jahn, H. (Kernforschungsanlage, Juelich, Ger.). Kerntechnik, 8: 449-52(Oct. 1966). (In German).

Investigations were made which prove that methane-gas proportional-counters are useful for the detection and measurement of ^{41}Ar concentrations at nuclear reactors. The instrument used has a sensitivity of $4{,}8 \cdot 10^{10}$ $(1 \pm 0{,}1)$ counts $min^{-1}/\mu Ci\ cm^{-3}$. The results of measurements are compared with theoretical values of the counter sensitivity. Further experience from the use of the counter in reactor operation is reported. (auth)

12263 SIMPLE ELECTRICAL DETECTION METHOD FOR SHAPE CHANGES OF FUEL ELEMENTS OF A PEBBLE-BED REACTOR. Hecker, R. (Kernforschungsanlage, Juelich, Ger.). Kerntechnik, 8: 445-9(Oct. 1966). (In German).

Intact spheres of an electrically conducting material have a different effect on the behavior of an oscillator circuit compared with spheres of the same material the dia of which is changed by damages. This effect could be applied for identification of damages of spherically shaped fuel elements in pebble-bed reactors. An electronic device was developed and is described which is able to indicate such damages. The signals gained can easily be utilized in a mechanism for discarding these balls. (auth)

12264 NONDESTRUCTIVE EXAMINATION OF RADIOACTIVE MATERIAL USING NEUTRON RADIOGRAPHY. Carbiener, Wayne A. (Battelle Memorial Inst., Columbus, Ohio). Nucl. Appl., 2: 468-70(Dec. 1966).

A technique for applying neutron radiography to the examination of radioactive material is described. This method uses a pool reactor core as a neutron source and the water as a biological shield. Radioactive specimens examined include clad fuel rods up to 1.2-m in length and stainless steel capsules up to 2.9-cm dia and 60-cm long. Representative radiographs of both types are presented. (auth)

12265 BUBBLE MIGRATION AND FISSION GAS RELEASE FROM UO_2. Biersack, Jochen (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nukleonik, 8: 439-42(Nov. 1966). (In German).

A universal formula for the velocity of bubbles in a thermal gradient is given. This formula is applied to investigate the fission gas release from UO_2-cylinders by moving bubbles. In agreement with empirical data, the fractional release is found to be close to 1 for inactive gases. For radioactive gases, fractional release values are obtained which may be below 1, depending mainly on the temperature and the decay constant. An explanation for the swelling of ceramic and metallic fuels is given. (tr-auth)

12266 A UTILITY-ORIENTED VIEW OF FUEL PERFORMANCE REQUIREMENTS FOR WATER REACTORS. Gray, John E. (NUS Corp., Washington, D. C.). Nucl. Appl., 2: 489-91(Dec. 1966).

While many basic fuel performance requirements are the same for fossil and nuclear power plants, in the latter additional performance requirements must be considered, e.g., the computation of fuel cost complicated by relatively long energy extraction time and energy variations between core areas, the necessity for fuel management, the increased complexity of fuel design and procurement, the need for shipment and reprocessing of radioactive spent fuel, and the large degree of government control over fuel. Therefore, the utility-oriented view of fuel performance requirements for water reactors recognizes nuclear fuel as high-precision equipment with complex lifetime characteristics and very high capital value. (auth)

12267 TEMPERATURE DEPENDENCE TO 1550 DEG C OF THE EFFECTIVE RESONANCE INTEGRAL OF THORIUM OXIDE RODS. Schoenig, F. C.; Quisenberry, K. S.; Stricos, D. P.; Bernatowicz, H. (Knolls Atomic Power Lab., Schenectady, N. Y.). Nucl. Sci. Eng., 26: 393-8(Nov. 1966). (KAPL-P-3058(Rev.)).

The temperature dependence of the thorium-oxide resonance integral has been measured over a wide (20 to 1550°C) temperature range. The activation method was used and the 310 keV γ-ray from the decay of ^{233}Pa was measured with a multichannel pulse-height analyzer. Measurements were performed on ThO_2 rods of 0.490- and 0.353-in. dia (surface-to-mass ratio = 0.340 and 0.465 cm^2/g, respectively). The temperature dependence of the thorium-oxide resonance integral was found not to be a linear function of either $(t-t_0)$ or $(\sqrt{T}-\sqrt{T_0})$, where t and T and centigrade and Kelvin temperature, and t_0 and T_0 are 20°C, and 293°K, respectively. Thus the familiar forms of the temperature dependence of the effective resonance integral, namely $RI(T)/RI(T_0) = 1 + \alpha\ (t-t_0) = 1 + \beta \times (\sqrt{T}-\sqrt{T_0})$ are not appropriate representations of the data. The Doppler coefficient in a 1/E spectrum is defined by $\alpha_0 = [1/RI(T)]\ [dRI(T)/dT]$, where RI(T) is the effective resonance integral of the sample excluding the 1/v contribution, and T is the temperature of the sample. It has been found that $\alpha_0 = [(0.16 \pm 0.01)/T]$ yields a good fit to the experimental data of both sample sizes. (auth)

12268 IMPROVEMENTS IN OR RELATING TO LOAD ENGANGING AND SUPPORTING DEVICES. (to Babcock and Wilcox Ltd.). British Patent 1,050,069. Dec. 7, 1966. Priority date Sept. 24, 1964, Sweden.

A disconnectable load engaging and supporting device, particularly suitable for moving a fuel element longitudinally within a fuel channel in a reactor is described. The device includes a body portion carrying a pair of levers, each suspended from the body portion by a horizontal pivot with means provided for biassing the levers toward each other. A plunger is operable reciprocally between the two levers from a first position in which it holds the levers apart to a second position in which it permits the levers to swing towards each other and serves to move the levers, in passing between these positions, to a separation greater than that which they occupy when the plunger is in either position. The facing edges of the levers are each shaped to provide a ledge between the pivot point and the lower end of the lever with a portion converging downwardly, when the punger is in the first position, towards a corresponding portion of the other lever and a portion diverging downwardly, when the plunger is in the second position, away from the corresponding portion of the other lever. The ledges together provide a support on which a load being supported by the device may rest. (B.L.M.)

12269 FUEL CELLS. Guicherd, Roger (to Commissariat a l'Energie Atomique). British Patent 1,053,018. Dec. 30, 1966. Priority date May 12, 1964, France.

The reactor fuel element described consists of a rectangular casing containing a series of parallel fuel plates. Two plates of neutron absorbent material slide in longitudinal grooves in the sides of the casing normal to the fuel plates and serve as control rods. The control plates are linked at one end by a stirrup and fitted with a piston and cylinder damper system. (H.D.R.)

GENERAL

12270 (LA-3592) IMPROVED METHOD FOR CALIBRATING A BEAM-SPLITTER AT HIGH TEMPERATURE. Horton, Robert L. (Los Alamos Scientific Lab., N. Mex.). Sept. 1966. Contract W-7405-eng-36. 11p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A device is described which improves the method of calibrating a beam-splitter in the range 2500 to 3000°C. (auth)

12271 (ORNL-TM-1693(Pt.7)) A SYSTEM FOR BIOMEDICAL DATA MANAGEMENT (DATASYS). PART VII. SYSTEMS INFORMATION. Katzan, H. Jr. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 15p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

DATASYS, as implemented at the Oak Ridge National Laboratory, uses the facilities of the IBM System/360 Operating System. Also required is an IBM direct access storage device, such as magnetic disk or drum. With the information contained herein, DATASYS can be generated and maintained by a moderately experienced computer programmer. (auth)

12272 (UCRL-50102) NEUTROPHIL SYSTEM. Wilbur, David W. (California Univ., Livermore. Lawrence Radiation Lab.). July 19, 1966. Contract W-7405-eng-48. 73p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An attempt is made to critically review the literature of the mammalian granulocyte with special emphasis on understanding the human neutrophil system. Particular attention is given to those parameters that seem most important in the construction of a dynamic mathematical model of this system which might for example be useful in the prediction of chemotherapy effects. A generalized model is presented as a basis for discussion. The kinetics and numbers of the cells in the blood and in the marrow production system are then discussed, and, where possible, the available experimental data are summarized in tabular form. Because of its critical importance, special effort is devoted to reviewing the stem cell problem. The response of the system to stress and its normal control mechanisms are also surveyed. Where possible, the mathematical relationships (often approximate) between the different parameters of the system are derived and applied to the available data. Finally, experimental problems and areas of greatest need are briefly discussed. (auth)

12273 (BNL-tr-117) STEADY-STATE CONDITIONS FOR CHAIN REACTIONS. Pis'men, L. M. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Zh. Prikl. Mekh. Tekn. Fiz., No. 3, 78-83(1966). 25p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $2.60 fs, $0.95 mf.

Processes involving one type of radical and those involving various types of radicals are discussed on the basis of the chain reaction theory. Linear equations of diffusion, which determine the radical concentration in a certain limited region, were investigated. Conditions for a stable steady-state process were determined. (M.C.G.)